MECHANICAL ENGINEERING

April 1959

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Inertial Navigation for the X-15

Do you need from 60,000 to 100,000 pounds of steam per hour? Have it delivered to your plant in one space-saving, dependable and economical package—the B&W Type FO Package Boiler for oil and gas firing.

What does the B&W Type FO Package Boiler offer you?

SUPERIOR PERFORMANCE

Capacity up to 100,000 lb/hr. Steam pressures from 250 to 775 psi. Temperatures to 750 F. The B&W Type FO Package Boiler gives you ample furnace volume and area in a really compact unit. It's the result of B&W's years of designing for reliable high capacity in small space for the Navy and Merchant Marine.

DEPENDABILITY

The entire furnace is water-cooled. That means less trouble; low maintenance. Also, the drainable superheater allows fast start-up and safe, rapid storage.

EASY CLEANING

The tubes are arranged for effective soot blower cleaning.

NATURAL CIRCULATION

It's the best way to bring you maximum reliability, simplicity, and minimum maintenance at low cost.

CLEAN, DRY STEAM

B&W Cyclone Steam Separators and Scrubbers guarantee minimum carryover, maximum circulation. Thousands of boiler installations have proved the superiority of Cyclone Separators.

EASY INSTALLATION

Remove it from the flatcar, make a few connections, start it up.

Three words sum up the advantages of the new B&W Type FO Package Boiler—*economy, convenience, quality.*

Get the complete details on the natural circulation, oil and gas fired B&W Type FO Package Boiler, from your local B&W Sales Engineer. Or write The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

G-913A IB

A plant built on the philosophy of "don't accept anything at face value"..

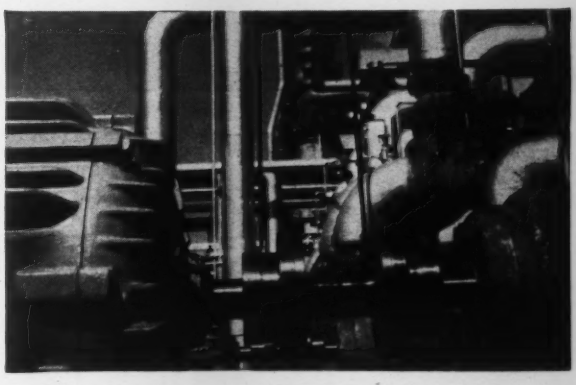
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 5704 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.

This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

The Schlitz "headquarters" brewery at Milwaukee uses 4 pulverized coal-fired C-E boilers, Type VU, each with a capacity of 60,000 lb. per hr.

Two oil-fired C-E boilers, Type VU-10, supply 60,000 lb of steam per hr. for process purposes at the Schlitz brewery in Brooklyn, N. Y.

This 20-million dollar showplace is the Schlitz brewery in Los Angeles, California, which uses 3 C-E boilers, Type VU-10. Fired with natural gas and oil, they generate 90,000 lb. of steam per hr.

At its Tampa, Florida, brewery, Schlitz uses 2 semi-outdoor C-E Package boilers, Type VP. They provide 72,000 lb. of steam per hr.

"The Beer That Made Milwaukee Famous"...

is brewed with C-E STEAM

Eleven C-E boiler units, ranging from the semi-outdoor, oil-fired package type to the pulverized coal-fired, vertical unit type, provide the steam to make "The Beer That Made Milwaukee Famous."

Since 1946, when the Jos. Schlitz Brewing Company purchased four C-E boilers as part of an expansion and modernization program at Milwaukee, the Company has purchased C-E units for its breweries in Brooklyn, N. Y., Los Angeles, Calif., and Tampa, Fla.

Due to the nature of brewing and bottling operations, load swings are wide and rapid, and boiler response must be both unfailing and prompt. How well C-E boilers have met this challenge is evidenced by the repeat order record—a record made even more impressive by the fact that the Jos. Schlitz Brewing Company has obtained consistently high performance with not just one type of C-E boiler — but with three.

When you need a reliable and efficient source of steam — remember that the Schlitz slogan "Move Up to Quality" applies to boilers as well as beer.

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

C-196A

Canada: Combustion Engineering-Superheater Ltd.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

MECHANICAL ENGINEERING

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THE COVER

In the foreground is the "stable platform," heart of the guidance system developed by Sperry Gyroscope Company of Great Neck, N. Y., for the X-15 rocket research craft. The system will direct the pilot from the instant of launch, through the extreme-acceleration phase, and enable him to control the craft during the critical re-entry. At the left is Dr. Carl A. Frische, president of Sperry. Nathan P. White, engineering chief of Sperry's Inertial Navigation Section, is shown working the equation of the "Schuler period."

DEVELOPING FROM AN ENGINEER TO AN ADMINISTRATOR.....**O. J. Sizelove** 54

Say you're a technical engineer, the best. Should you undertake management? Might be better for engineering if you didn't. But if it's for you, here are basic principles of your future job.

"MISSION CONCEPT"—THE ELECTRA PHILOSOPHY.....**C. F. Schmidt** 56

Now they design airliners around a specific mission—in this case, medium-range, high-density service. This is a report from the new man on the plane-builder's design team, the airline engineer.

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FINDING AND DEVELOPING TECHNICAL PERSONNEL
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.....**G. J. Goepfert and Josephine L. Williams** 69

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Put a flywheel outboard of the bearing, and you've set the stage for "whirl," complete with gyroscopic effects. A periodic torque will excite whirl, a problem in heavy, reciprocating machinery.

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Small bearings turning above 100,000 rpm, at 1000 F. At Fairchild, tests reveal evaporation breakdown and coking of lubricants. And there's the problem of high-speed dry seals for jet-fuel pumps.

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It is two years since initial operation of the Philo 6 development unit of the Ohio Power Company, a pioneer supercritical plant. Two 450,000-kw units are now being built, on Philo 6 experience.

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Bone-seeking radioelements somehow weaken the bones so that easy fractures occur. It happens to radium-dial workers. Experiments detailed here are a first step in understanding the phenomenon.

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How B&W JOB-MATCHED TUBES meet Heat-Exchanger requirements

With B&W Job-Matched Heat-Exchanger Tubes you get:

- ... tube tolerances and mechanical properties, controlled for ease of fabrication
- ... a wide range of steels to meet any set of operating conditions
- ... a complete range of tube sizes, for any type of heat exchanger

This means ease of fabrication to the heat-exchanger manufacturer — long service life to the heat-exchanger user—and ease of tube replacement to those concerned with maintenance.

For complete information about B&W Job-Matched Heat-Exchanger Tubes call the local B&W District Sales Office or write for Bulletin TB-329. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-9002-SPI

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

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NEW EDWARD IMPACTOGEAR

What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

How Impactogear* operates high-pressure valves

You no longer need a crew of men to open or close big, high-pressure valves. New Edward Rockwell-built Impactogear makes big-valve operation a quick and easy job.

FAST AND EASY "RUNDOWN"

Your operator simply applies portable air or electric wrench to pinion shaft-end of Impactogear. When power is applied, pinion turns ring gear, which turns handwheel and moves the stem to "closed" position. Impactor* handwheel then gives final tight shut-off with unique "hammer-blow" action. (Tests show it delivers 12 times the closing force of ordinary handwheels—with less effort!) Impactogear works quickly, can operate a 2500-lb 10" valve (for example) in only 2½ minutes. And Impactogear can be fitted to any 8" or larger Edward valve of 900-lb (or higher) pressure class.

IMPACTOGEAR WITH AIR WRENCH

Impactogear utilizes standard portable air or electric wrenches generally available throughout industry. Example below shows how two typical air wrench ratings can be applied:

Wrench Type No. 1—Stall torque 170 ft-lbs: Free speed 225 rpm; Weight 12 lbs

For 12" and 14" 2500 lb. valves, operating pressures to 3500 psi

For 10" 2500 lb valves, all allowable operating pressures

For 10", 12" and 14" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

Wrench Type No. 2—Stall torque 200 ft-lbs: Free speed 300 rpm; Weight 38 lbs

For 12" and 14" 2500 lb valves, operating pressures 3500 psi to 4500 psi

IMPACTOGEAR WITH ELECTRIC WRENCH

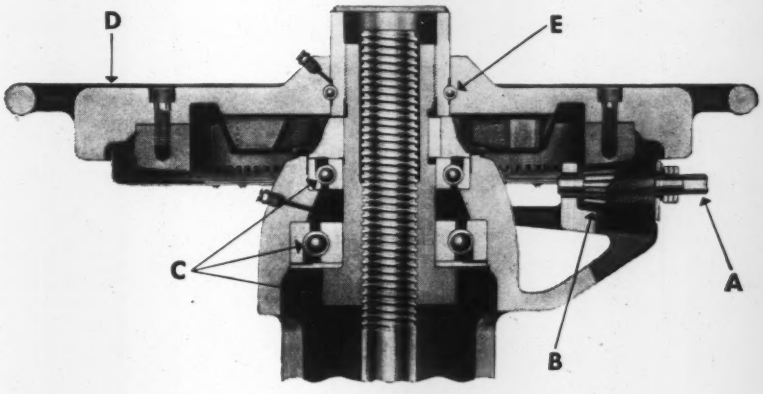
Portable electric wrenches are equally practical. Example below shows a typical electric wrench rating as applied to Impactogear:

Wrench Type No. 1—Stall torque 176 ft-lbs: Free speed 225 rpm; Weight 44 lbs

For 10" 2500 lb valves, all allowable operating pressures

For 10" and 12" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures



Details of new Impactogear and Impactor Handwheel:

A—Hex head of pinion gear shaft. Power wrench is applied here. B—12-to-1 bevel gear ratio is typical for median size handwheel. C—Exclusive EValthrust yoke bushing combines radial and thrust bearings for easy operation and long life. D—New Impactor handwheel concentrates mass near outer circumference for maximum impacting efficiency. E—New extra bearing increases operating efficiency.

SLASH COST OF VALVE OPERATION

Individually installed operating motors are a big investment. They can add as much as 100% to the basic valve cost. *But now you can save that money by standardizing on Impactogear*—radically simple, thoroughly dependable mechanism utilizing *existing* compressed air or electric facilities. Your Edward Representative will be glad to provide full details and help you determine how Impactogear can work to your best advantage. Contact him—or write *Edward Valves, Inc., 1228 W. 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

LIGHTWEIGHT PORTABLE WRENCH can operate as many Impactogear-equipped valves as desired. Or, each valve can be fitted with its own wrench. Either way, you get lower operating costs. Final closing is effected by handwheel lugs (A) striking hammer blows against cross arm keyed to yoke bushing (B). Half of gear cover was removed for illustration purposes.

*T.M. Reg. U.S. Pat. Off.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs: with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

DIAMOND

. . . NOW READY AND ABLE TO IMPROVE the CLEANING of

Shot cascading over horizontal tubular surfaces and through vertical air heater tubes, does an excellent job of removing soot and ash deposits from difficult-to-clean surfaces and those which foul rapidly.

Shot Cleaning has proved itself in more than 30 installations in the United States and in more than 800 installations in Europe. Many installations represent exceptionally difficult cleaning problems such as tubular air heaters, economizers and superheaters in black liquor fired boilers in paper mills. In a large central station, the system is now keeping air heaters clean which previously had to be water washed approximately every eight months, each washing requiring a three day boiler outage. With Diamond Shot Cleaning, draft losses are uniformly low and water washing has been eliminated entirely.

Shot is spread by distributors and cascades over tube surfaces ricocheting from tube to tube, or from side to side of internal surfaces of vertical air heater tubes. Much of the ash removed is carried off by flue gas. Heavier particles fall into the shot hopper and recirculate with the shot until broken fine enough to pass out with the gases. Shot accumulated in the hopper is lifted pneumatically to the storage area and reused continuously. Areas which tend to foul rapidly can be kept completely clean by increasing the length of the shot cycle (it can be continuous if necessary) without disturbing boiler operation.

Over a period of years Diamond has conducted extensive research in shot cleaning, as a part of our half century policy of providing the best in boiler cleaning. To supplement this program, Diamond has acquired U.S. rights to the Broman-Ekstrom system used in Europe.

WRITE FOR BULLETIN 2145AA ON
DIAMOND-BROMAN SHOT CLEANING

Diamond Gives You
BETTER BOILER CLEANING
At Lower Cost

Diamond

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Shot Cleaning System

TUBULAR AIR HEATERS

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ECONOMIZERS

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HORIZONTAL SUPERHEATERS

•

REHEATERS

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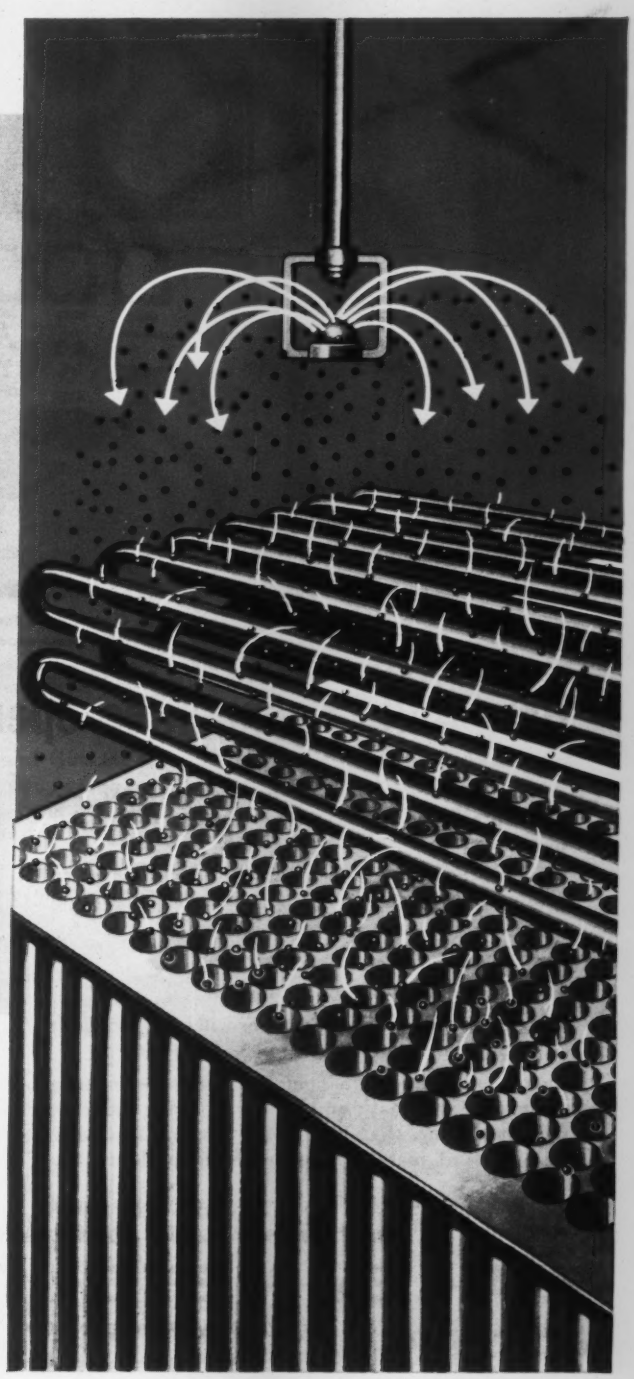

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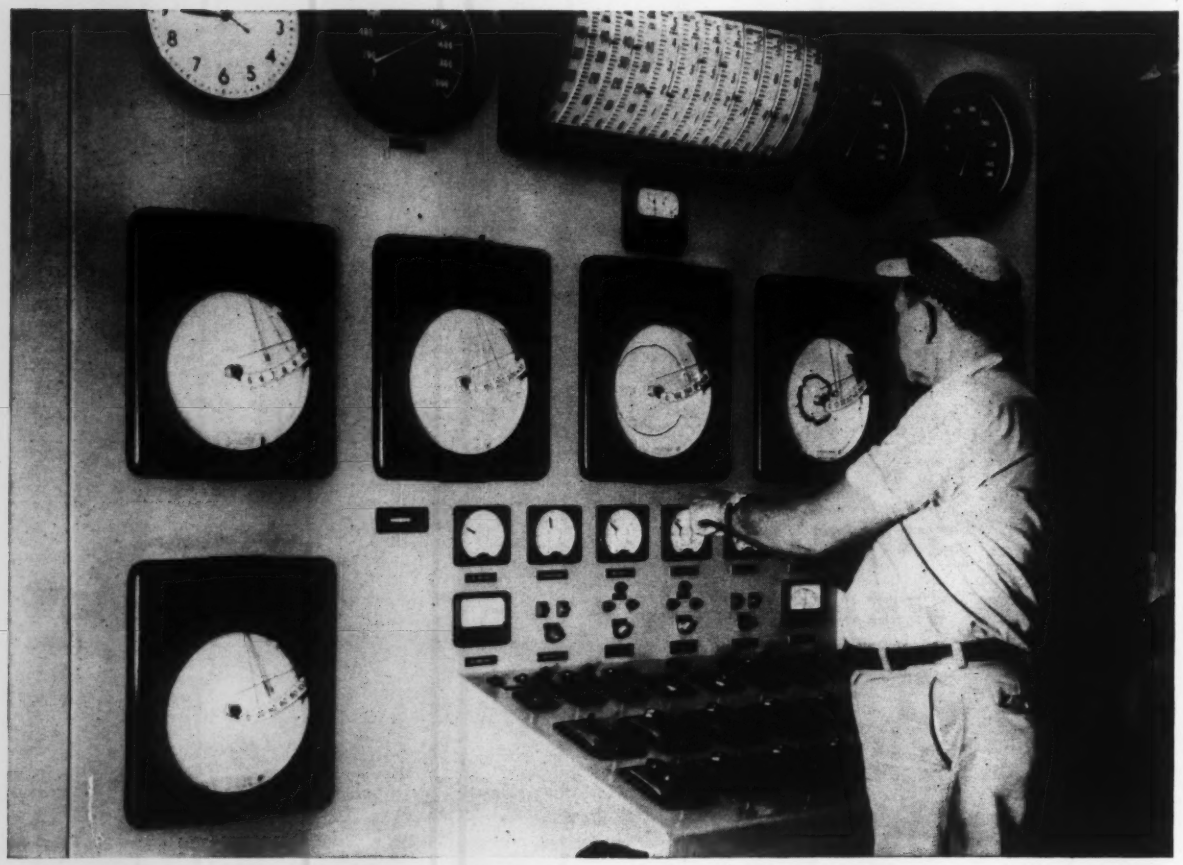

Control Room for Cyclone Furnace Boiler at Mathews No. 2 Power Plant of Greenwood Mills, Greenwood, S. C. Bailey MINI-LINE System concentrates controls at operator's station.

How BAILEY simplifies operation of STEAM PLANTS

Your operators can work more efficiently, make adjustments faster when you put Bailey Controls at their finger tips.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report.

Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs.

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment, that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant problems.

A138-1

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

SAFE SEALING WITH FLEXITALLIC

a tradition with engineers since 1912

Flexitallic Spiral-Wound Gaskets are bought for what they do . . . and keep on doing . . . in pipe lines and pressure vessels across almost all industry.

Flexitallic Gaskets are the safe seal, preferred by engineers since the development of the original Flexitallic Spiral-Wound construction in 1912.

In confining fluids at high pressures, and high temperatures, engineers know and depend on Flexitallic Gaskets because:

- The compression characteristics for a given series are always related to the bolting load for that series.
- With the gasket design determined, exacting mechanical controls assure that manufactured gaskets conform to specification.

To get this unvarying standard of quality in Spiral-Wound Gaskets, look for the blue dye in the Canadian asbestos filler — Flexitallic Blue, the mark of an engineered Flexitallic Gasket.

FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

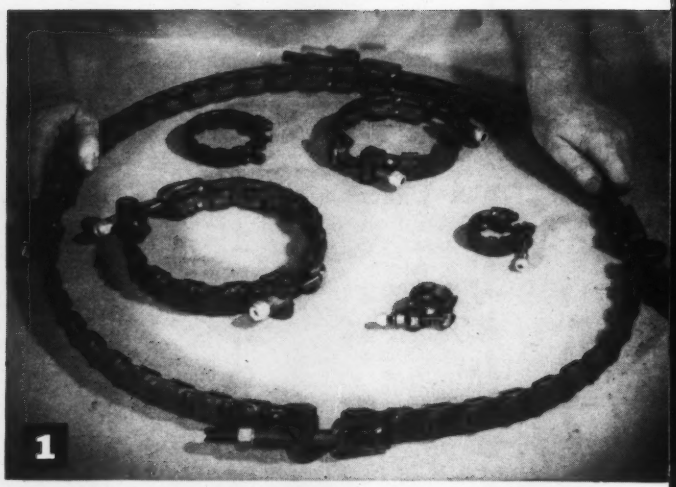
FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — its our exclusive blue-dyed Canadian asbestos filler.

"fingers" of hot-strong Inconel "X" grip harder as temperature rises in new couplings

As these quick-on, quick-off couplings for high pressure or high vacuum lines get hot, Inconel "X"* age-hardenable nickel-chromium alloy "fingers" grip harder and harder, seal tighter and tighter. Couplings weigh and cost less than bolted flanges.

For detailed information on the Temperature Compensating Couplings described in this advertisement, write the manufacturer, D.S.D. Manufacturing Company, Hamden, Conn.



Versatile new couplings...

HOW THEY WORK The pictures above show (1) several completed couplings; (2) details of the quick-on, quick-off clamp; (3) a cross section through a pair of one coupling's "fingers".

Notice these "fingers". They are Inconel "X" alloy curled into a tight semicircle and lined on the inside with Nickel-containing stainless steel strip.

Alloy helps insure leak-proof oper-

Hot-strong Inconel "X" tabs...

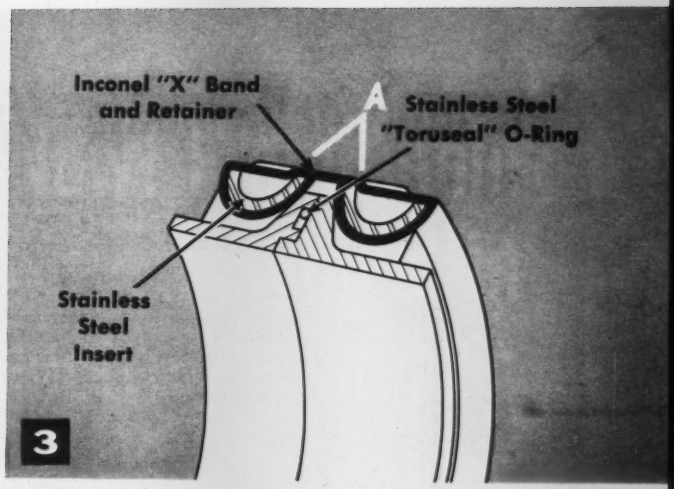
HOW THEY ARE MADE The pictures immediately above show (4) a stamped and partially bent Inconel "X" band; (5) "fingers" fully formed with stainless steel inserts in place; (6) "hot" test fixture with typical test results.

Notice how the designer takes advantage of the special properties of Inconel "X" alloy.

First, he uses the low expansion and low creep properties of Inconel "X" alloy to limit short and long term changes in overall dimensions.

Second, he depends on the superior spring properties of Inconel "X" alloy – even at high temperatures – to assure leak-proof operation of the couplings over wide temperature and pressure conditions ... from −320°F to +1750°F ... from 0.8 microns vacuum to 8000 psi.

lock and release quickly...



tighten as heat rises...

"Fingers" work like a bimetal... uncoiling as temperature goes up to grip harder and harder. As temperature drops, "fingers" recoil... up to a point. Then shoulders (A) stop the "finger" motion. Even sub-zero temperatures make no further change in initial sealing tension.

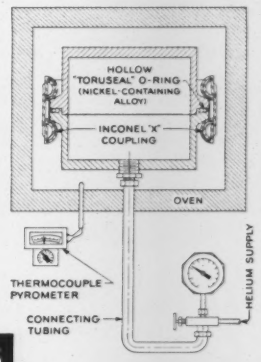
Initial sealing tension is obtained by tightening Inconel "X" T-head clamp-bolts (one to four, depending on coupling diameter). Seal is established by hollow "Toruseal"** O-Rings... usually made of Nickel-containing Type 321 stainless steel or of Monel* nickel-copper alloy.

*Registered trademark
**T.M. of D.S.D. Manufacturing Company
The International Nickel Company, Inc.

ation from −320° to +1750° F and from 0.8 microns vacuum to 8000 psi

curled into bimetal "fingers"...

TEST ASSEMBLY AND RESULTS FOR TEMPERATURE COMPENSATING COUPLINGS



Test assembly shown left provides more severe conditions than ordinary operation where couplings are exposed to cooler ambient temperatures. Temperatures are for entire assembly, including gas in duct. Test assemblies were held at heat long enough to attain steady state.

Coupling Size, in.	Temperature, °F	Pressure Lbs	Results
1½	−90	300-245	No leak
1½	70	1830	No leak
3½	1000	201	No leak
3½	1100		
	1200	76	No leak
6½	70	200	No leak
6½	70	high vac	No leak
7	750	50	No leak
7	70	150	No leak

prevent leaks in most environments

Third, he takes advantage of the ductility of Inconel "X" at sub-zero temperatures to extend the useful temperature range of the coupling down close to absolute zero.

Fourth, he counts on the outstanding corrosion and oxidation resistance of Inconel "X" alloy to prevent scaling of "fingers" and eating away of threads.

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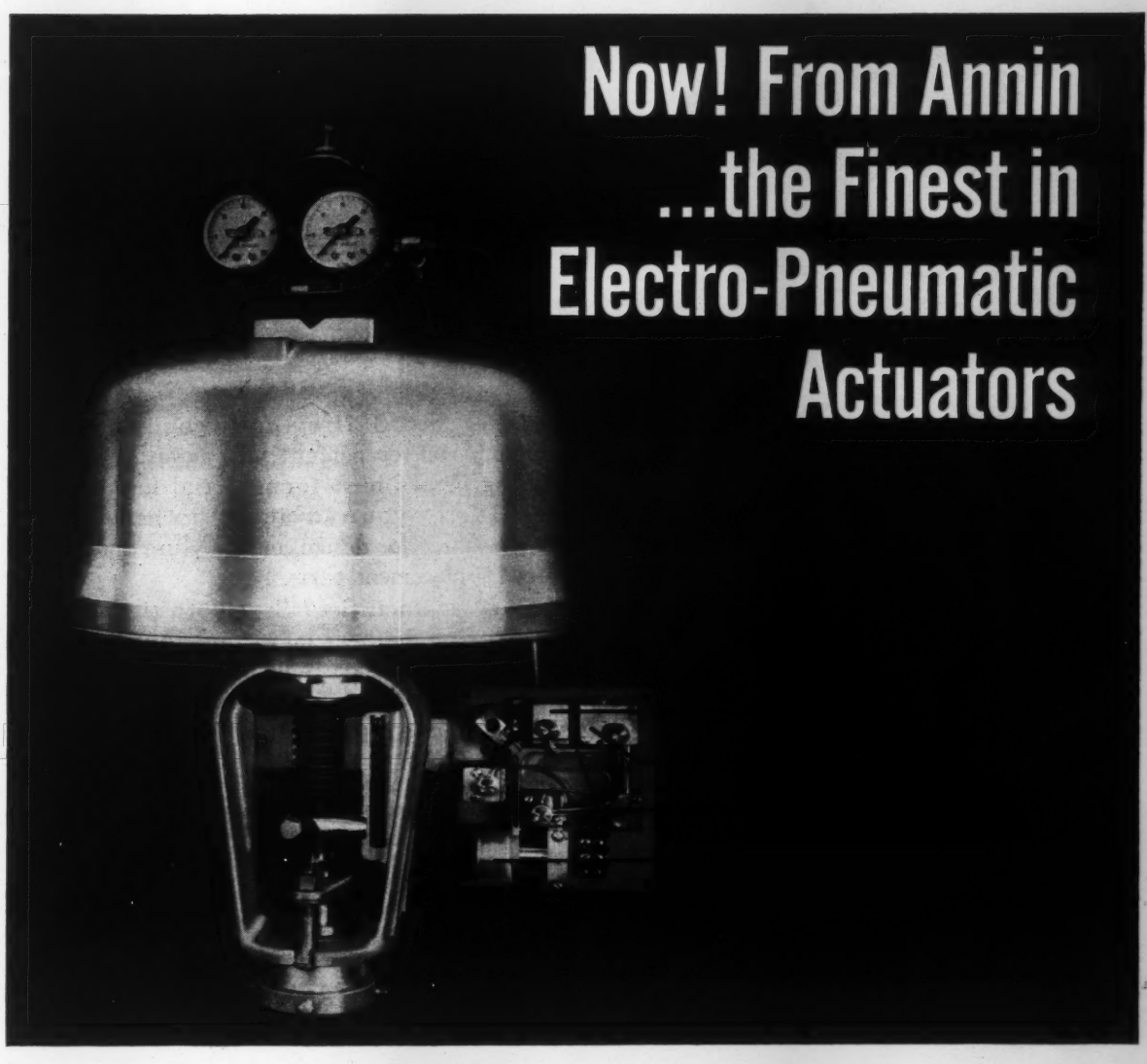

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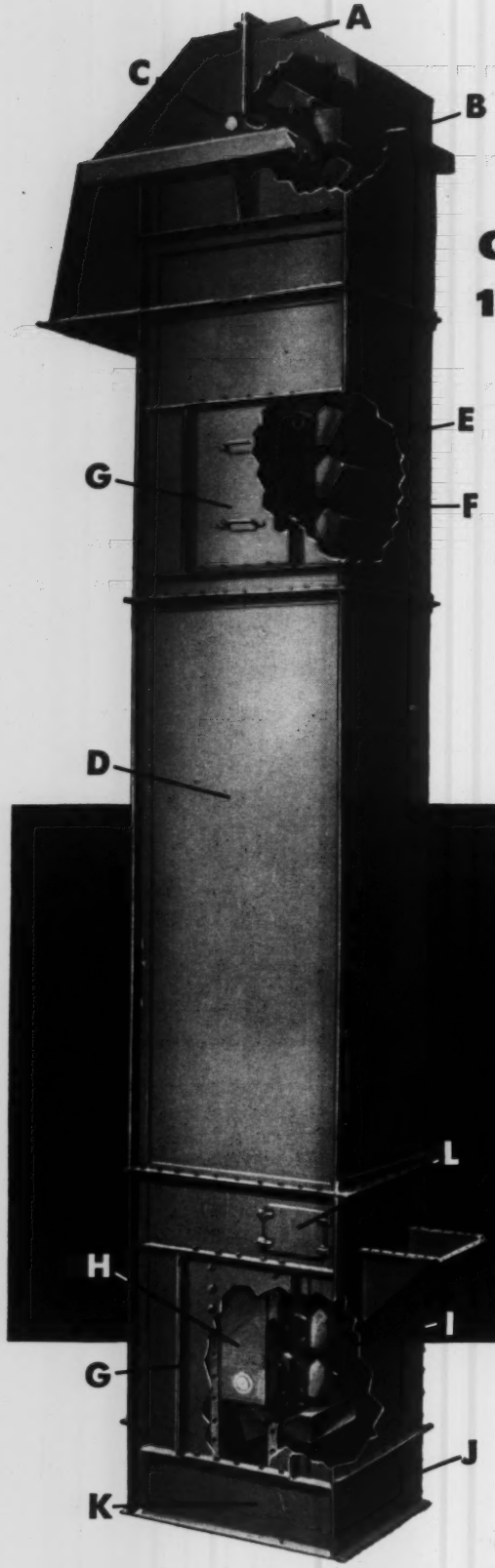

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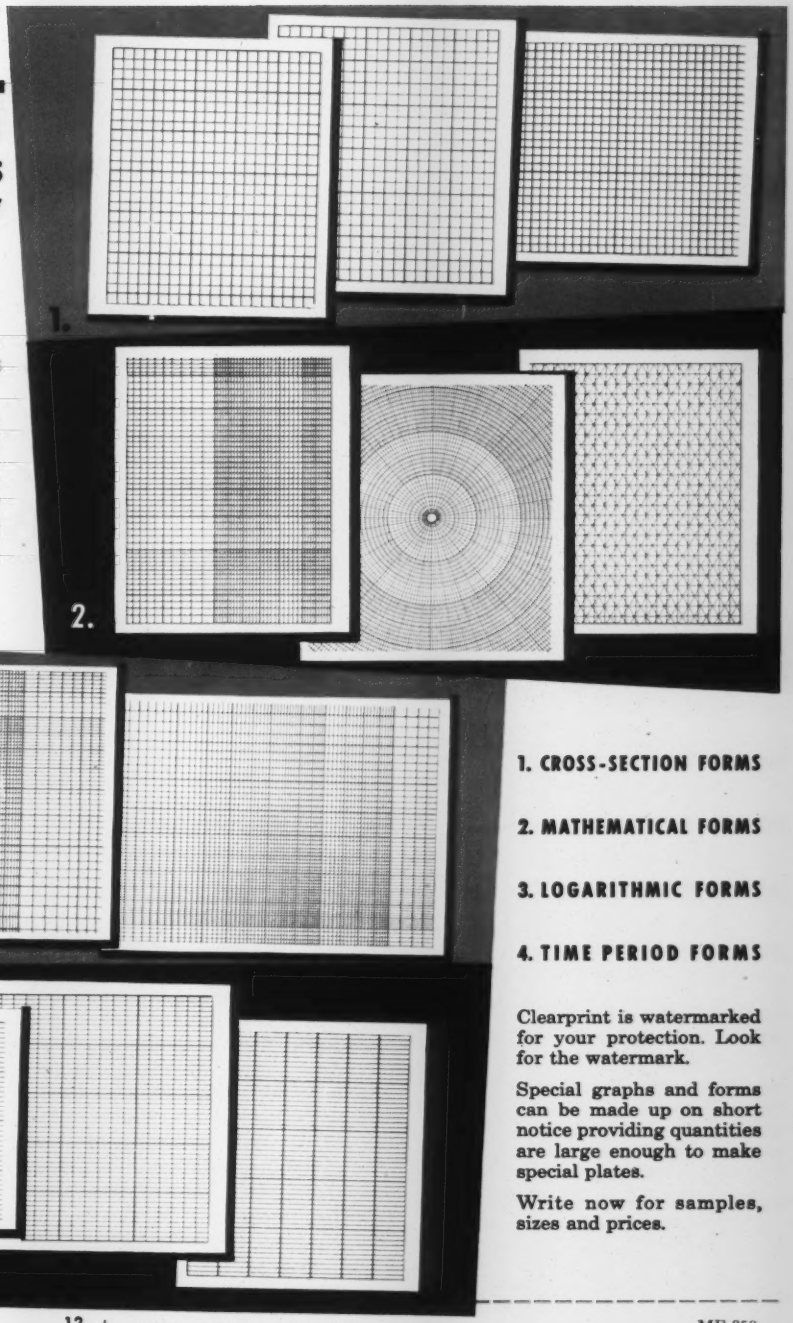

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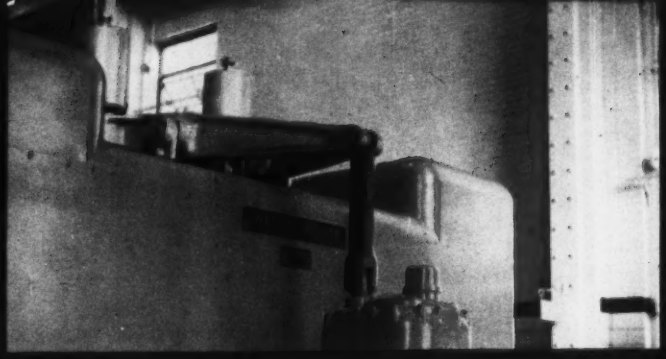

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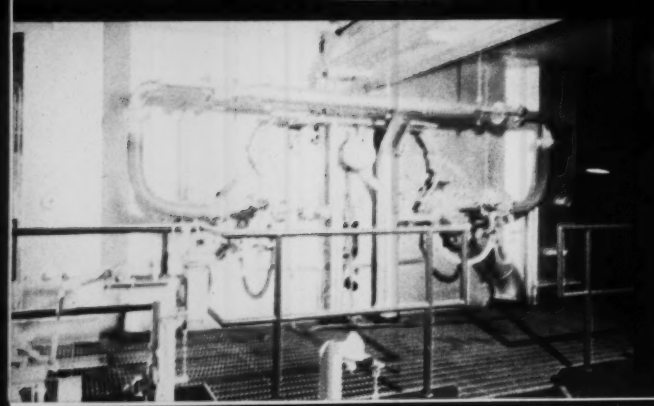

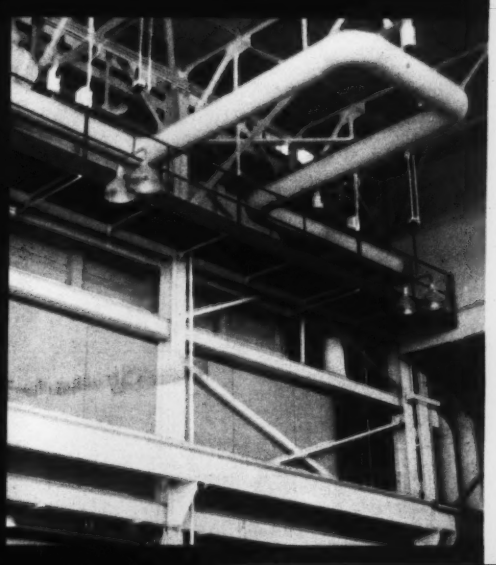

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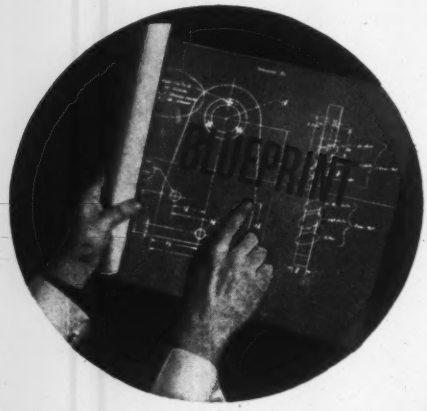

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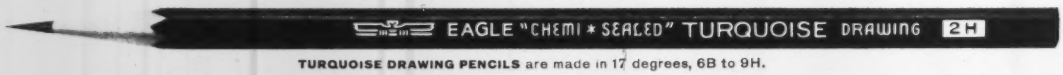

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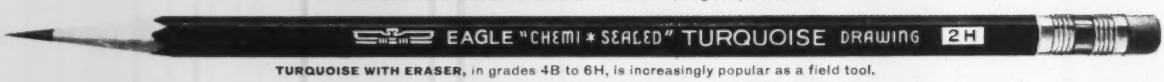

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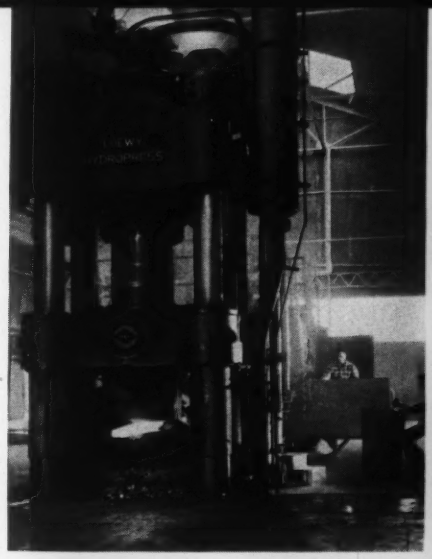
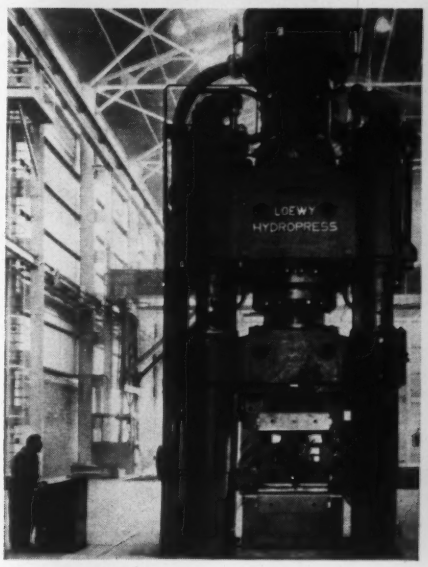
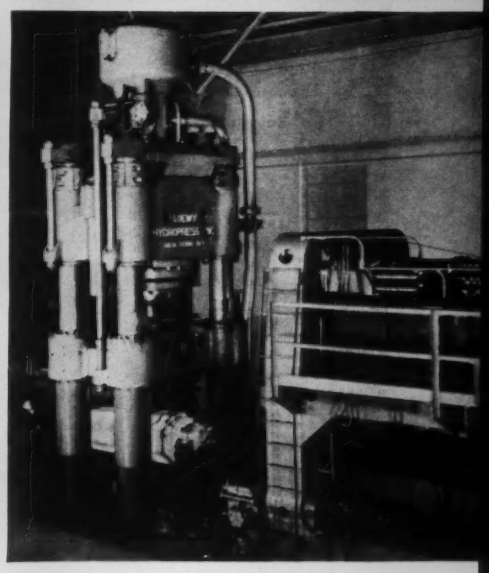


2000-ton press at Colonial Steel Division of Vanadium-Alloys Steel Co., Monaca, Pa. (left)

1500-ton press at leading alloy steel manufacturer in southern Pennsylvania.



2000-ton press at Simonds Saw & Steel Co., Lockport, N.Y. (left)



2000-ton press in operation at the Titusville, Pa., plant of Universal-Cyclops Steel Corp.

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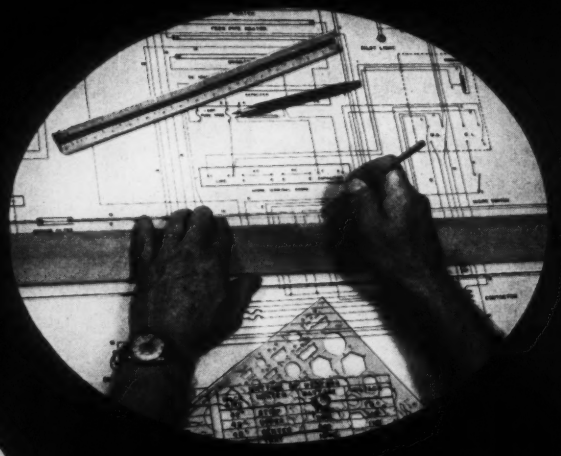

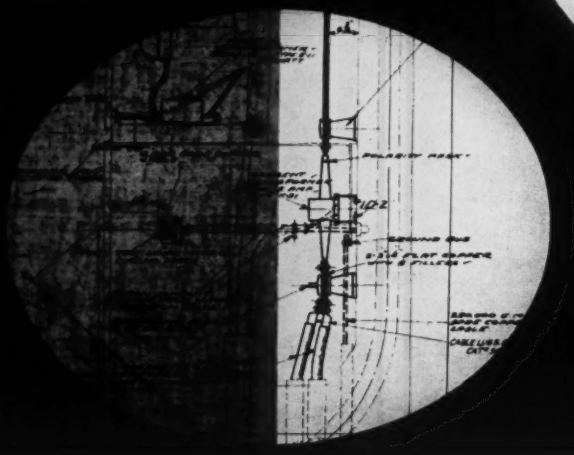

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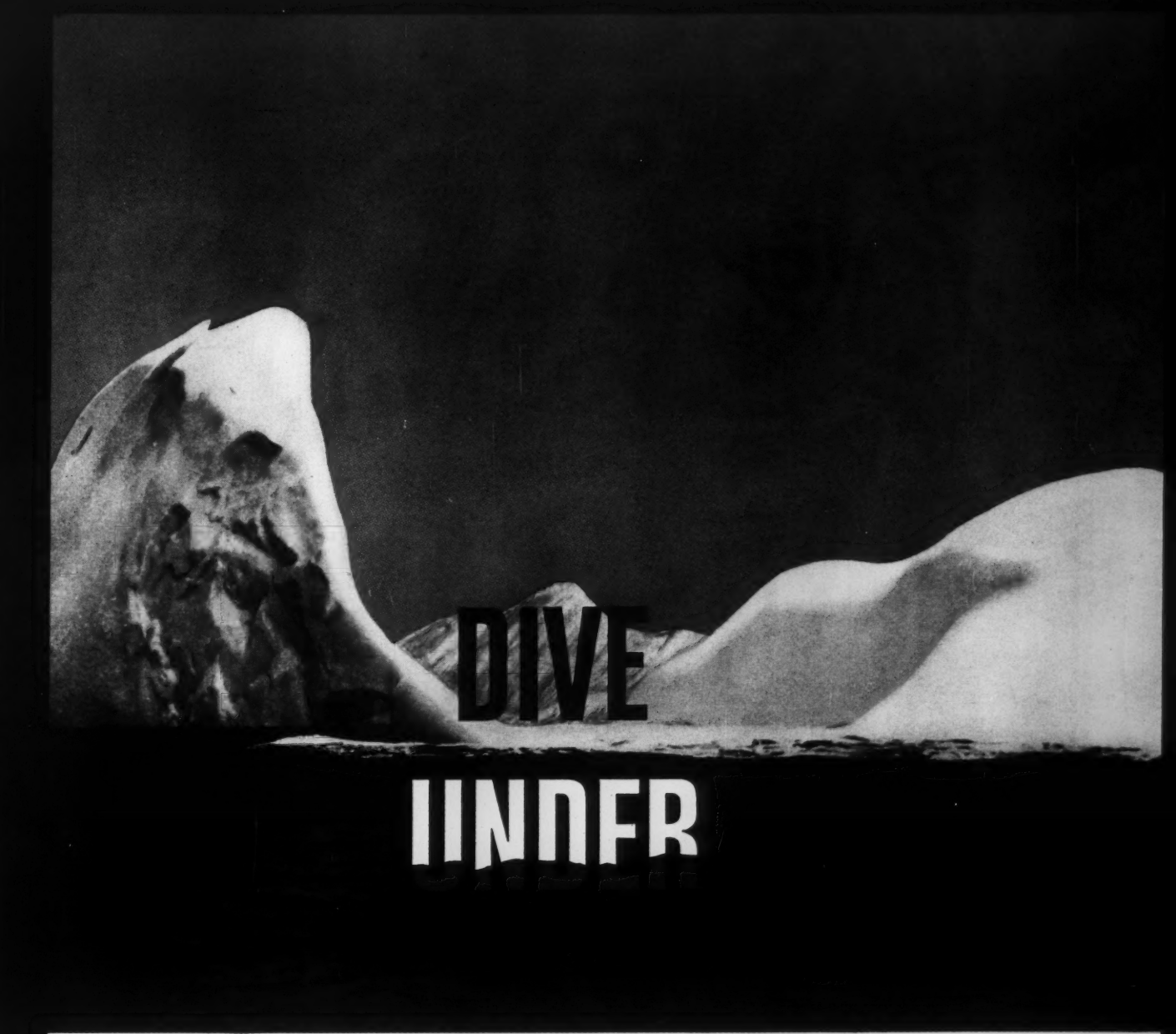

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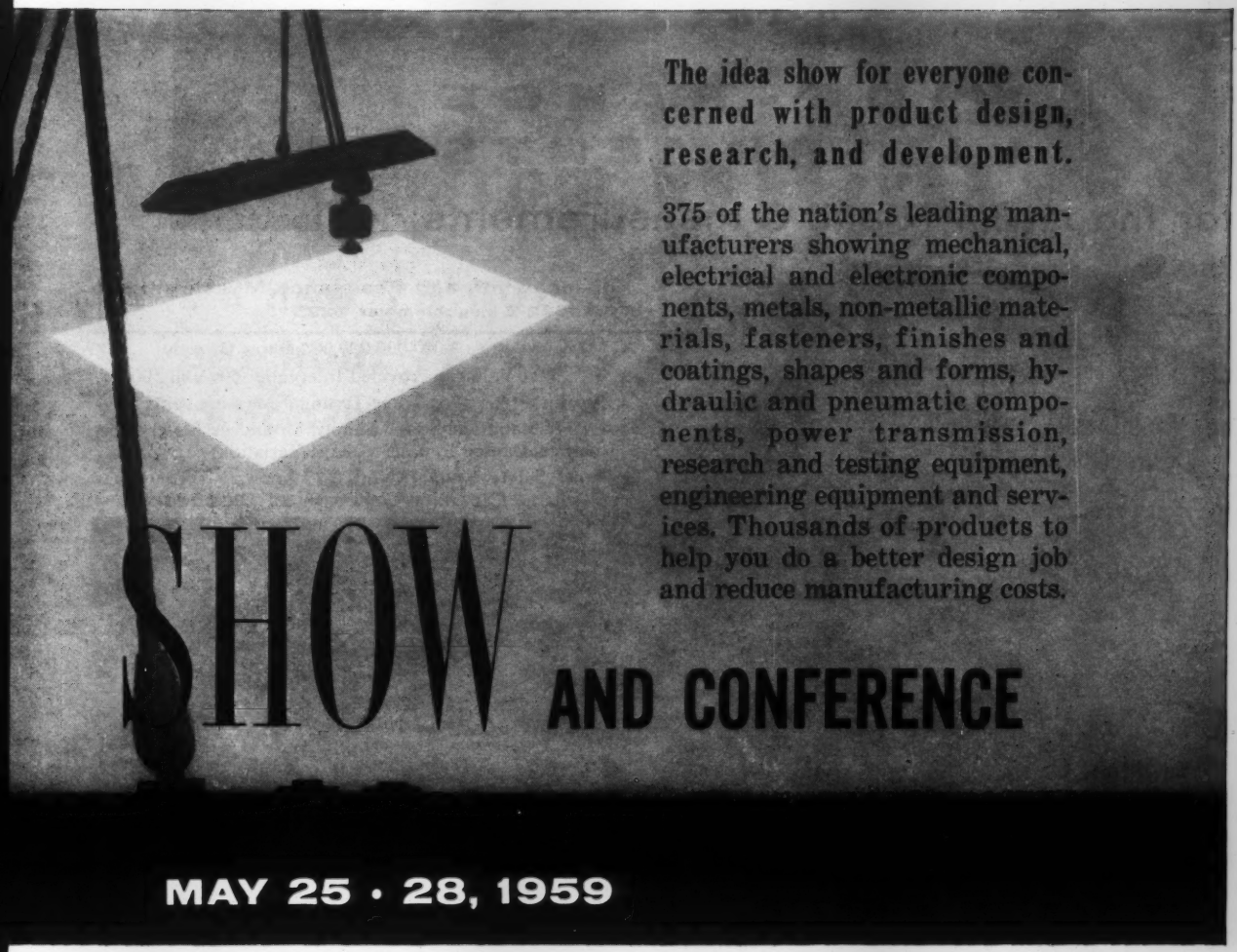

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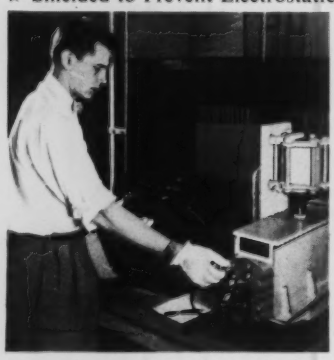

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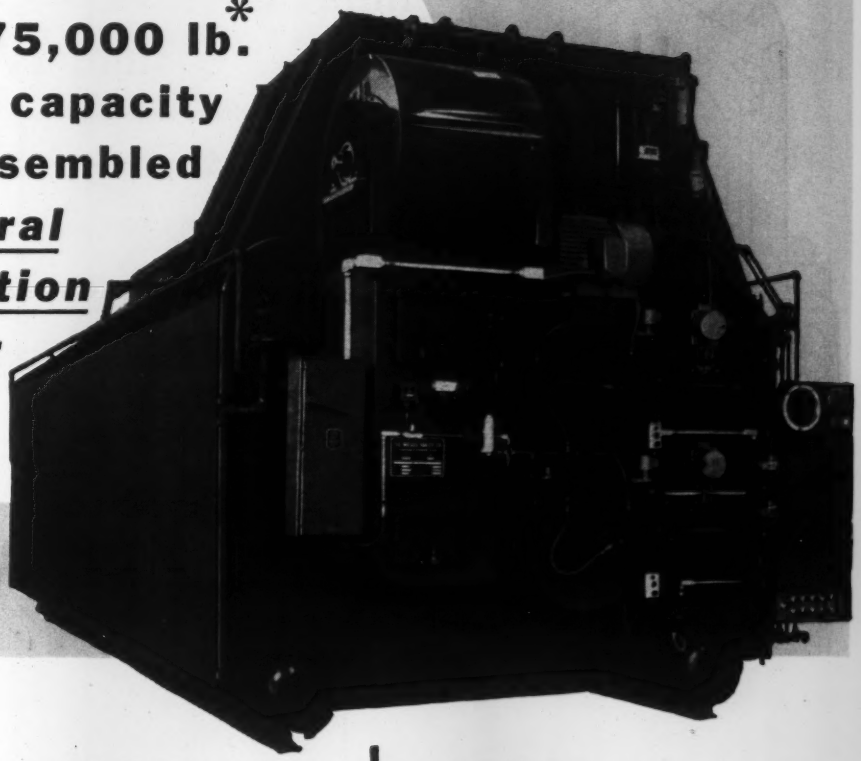
a new 75,000 lb.* per hour capacity shop-assembled *natural circulation* boiler



*75,000 lbs. per hour present capacity.
80,000 lbs. per hour future capacity with economizer

Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be Oil or Gas Fired.

All units are shipped completely shop-assembled including superheater fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

Save on

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- Operating Expense
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For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

WICKES type A

WICKES

WICKES BOILER CO., SAGINAW 13, MICHIGAN
DIVISION OF THE WICKES CORPORATION

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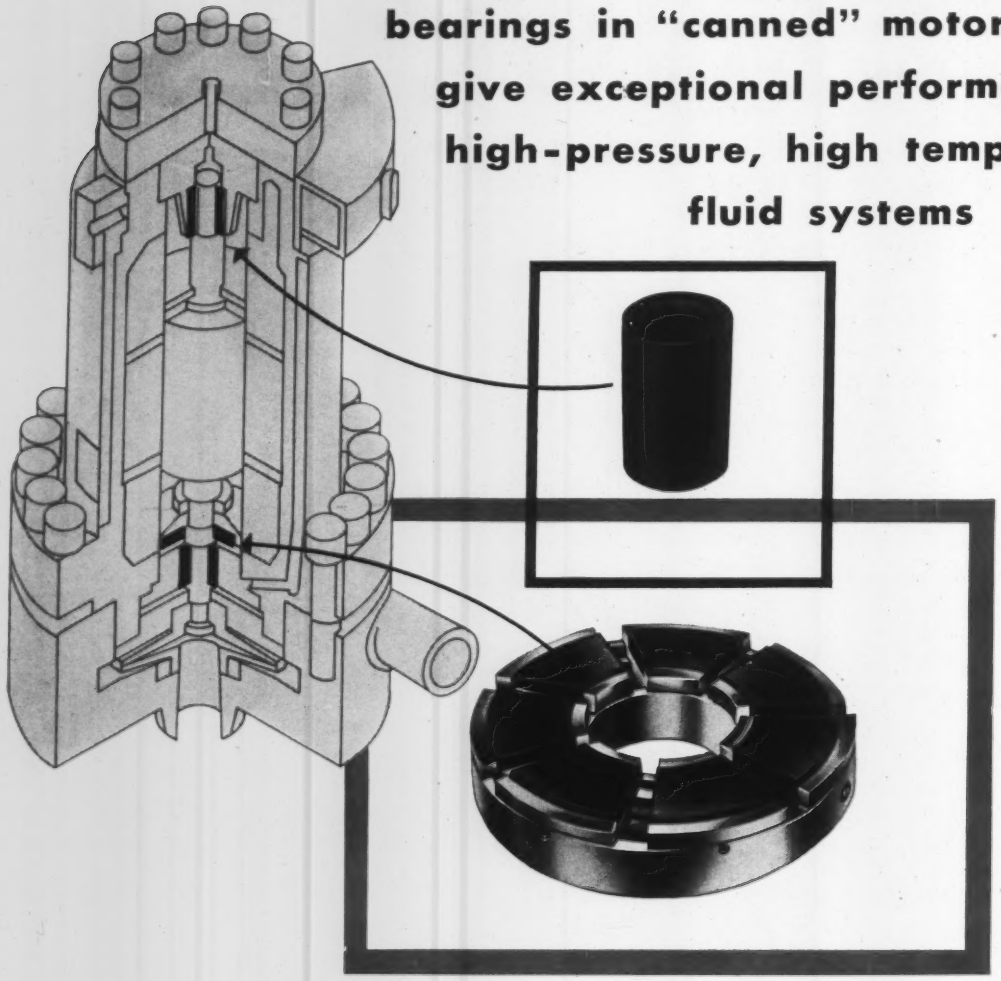
169

water-lubricated GRAPHITAR® (CARBON-GRAPHITE) bearings in "canned" motor pumps give exceptional performance in high-pressure, high temperature fluid systems



Special hermetically sealed motor-pumps, known also as "canned" motor pumps, were developed by Westinghouse Electric Corporation to handle radioactive water with zero leakage. These same pumps have proven a convenient means of pumping high temperature fluids for a number of nuclear reactors and other high pressure, high temperature fluid applications.

The thrust bearing utilized in the "canned" motor pump is a self-equalizing, water-lubricated, pivoted-pad bearing with inserted GRAPHITAR bearing surfaces. The radial sleeve bearings are also made of GRAPHITAR and are designed to be lubricated by the pumped fluid only . . . in the case of pumps used in nuclear reactors, only radioactive hot water is employed as lubrication.

GRAPHITAR is utilized extensively in tough applications because of its many unusual properties. It is non-metallic, resists chemical attack, has self-lubricating properties, a low coefficient of friction, is mechanically strong, hard as steel and lighter than magnesium. GRAPHITAR will not warp and shows no expansion or contraction in extreme temperature changes.

This versatile engineering material, GRAPHITAR, may well solve one of your difficult design problems. For further information on GRAPHITAR and its many applications, send for our engineering manual No. 20.

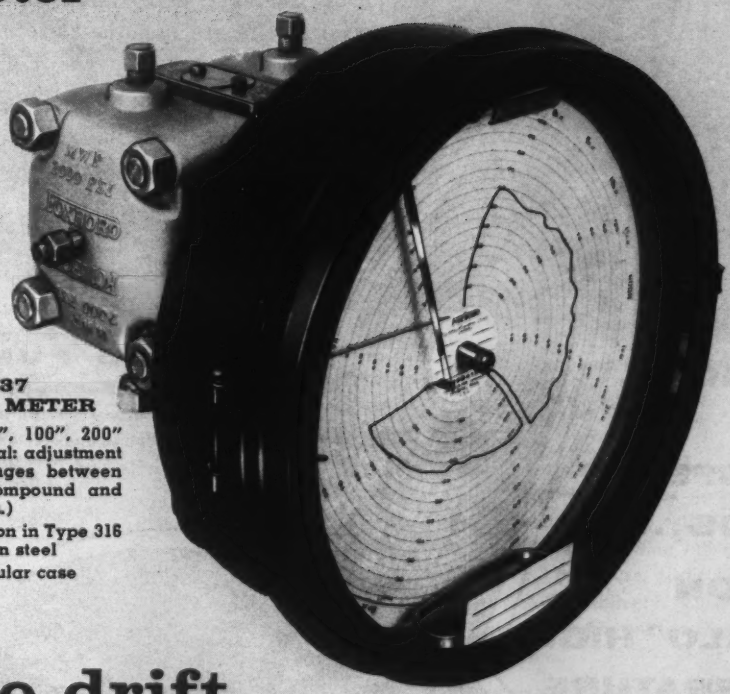
R-266-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

unmatched stability in a "dry" flow meter



FOXBORO T/37 DIAPHRAGM METER

- **Ranges: 20", 50", 100", 200" standard (Optional: adjustment for full scale ranges between 25" and 200"; compound and expanded ranges.)**
- **Forged construction in Type 316 stainless or carbon steel**
- **Round or rectangular case**

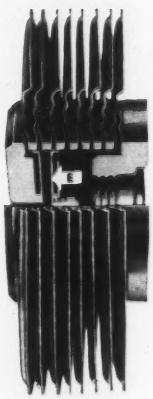
No zero drift... Complete overrange protection

Mercuryless flow measurement over a wide range of differential pressures — at static pressures up to 2000 psi (2500 psi optional). That's the story behind Foxboro's unique Type 37 Diaphragm Flow Meter.

No matter how often you check its accuracy you'll find no need to reset zero or span. Four vital construction features assure this remarkable stability:

1. Unique nesting diaphragm element of Type 316 S.S. which responds to changes in pressure with unmatched sensitivity yet cannot be damaged by overrange . . .
2. Packless drive bar which transmits precise linear motion to pen arm without "hang-up" . . .
3. Bi-metallic temperature compensator which precisely counteracts changing volume of the filling fluid . . .
4. Heavy Ni-span C alloy range springs which are unaffected by changes in line temperature . . .

Get full details on this high utility, completely dependable dry flow meter. Write for Bulletin 7-15A. **The Foxboro Company, 964 Neponset Ave., Foxboro, Mass.**



Type 316 S.S. diaphragm elements, in both high and low pressure chambers, provide greatest linearity and freedom from hysteresis. Nesting design, and integral spacer rings provide positive overrange protection. Bi-metallic temperature compensator (E) adjusts the capacity of the diaphragm assembly to counteract changing volume of the filling fluid.

FOXBORO
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first in flow metering

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These pumps are designed especially for handling high temperature liquids. The following description will help you evaluate the suitability of these pumps for this specialized service.

In addition to these special features, "Buffalo" High Temperature Pumps bring you the famous "Buffalo" hydraulically efficient impeller and casing design. Accessibility, dependability and long, maintenance-free life are important *extra* values in every "Buffalo" Pump.

Whatever your heat transfer problem — including vapor phase — phone your "Buffalo" engineering representative for full information.

Only "Buffalo" Pumps bring you the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

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A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

BUFFALO PUMPS

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"SPECIAL" Welding Fittings

by MIDWEST

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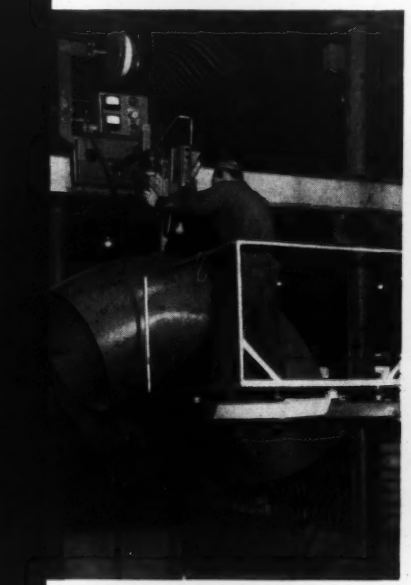
"SPECIAL" DELIVERY

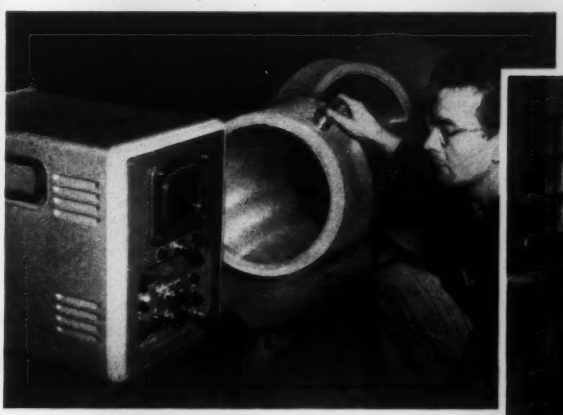
Special gauges and instruments are used to make sure that we have complied with the extremely close tolerances often required on stainless fittings. Here wall thickness and concentricity were held within extremely close limits throughout the fittings.

The exclusive Midwest method of manufacture—much more versatile and flexible than any other—enables us to make almost any type of special welding fittings to the most rigid specifications. Midwest makes welding fittings from *plate* . . . usually much easier to get than pipe, particularly if the material is special. That expedites delivery. Closer tolerances are inherent in the Midwest process, and quality control is always beyond code requirements.

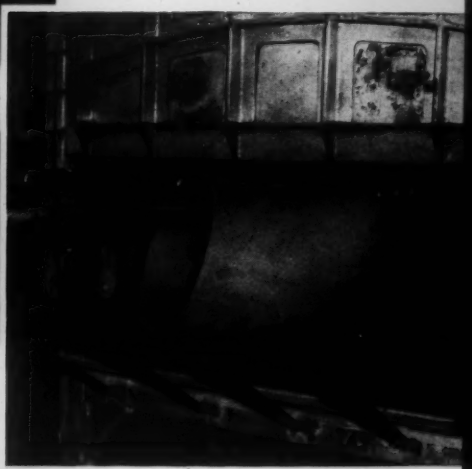
Even if you use only standard fittings, the exceptional quality of Midwest fittings can be important to you. Ask your Midwest distributor or write us for new Bulletin 5801.



36" O.D. 90° elbow with 16" tangent on one end being welded by an automatic submerged arc machine. Material is A-201 carbon steel.



Stainless-clad elbows undergoing ultrasonic inspection to check bonding of material and quality of weld. Since plate is often the only form in which clad material is available, the Midwest process is able to produce the most comprehensive range of clad fittings—and to do so promptly.



Special 24" x 21" 45° reducing elbow made of 1" thick 1¼% chrome ½% moly steel ready for heat treating furnace.

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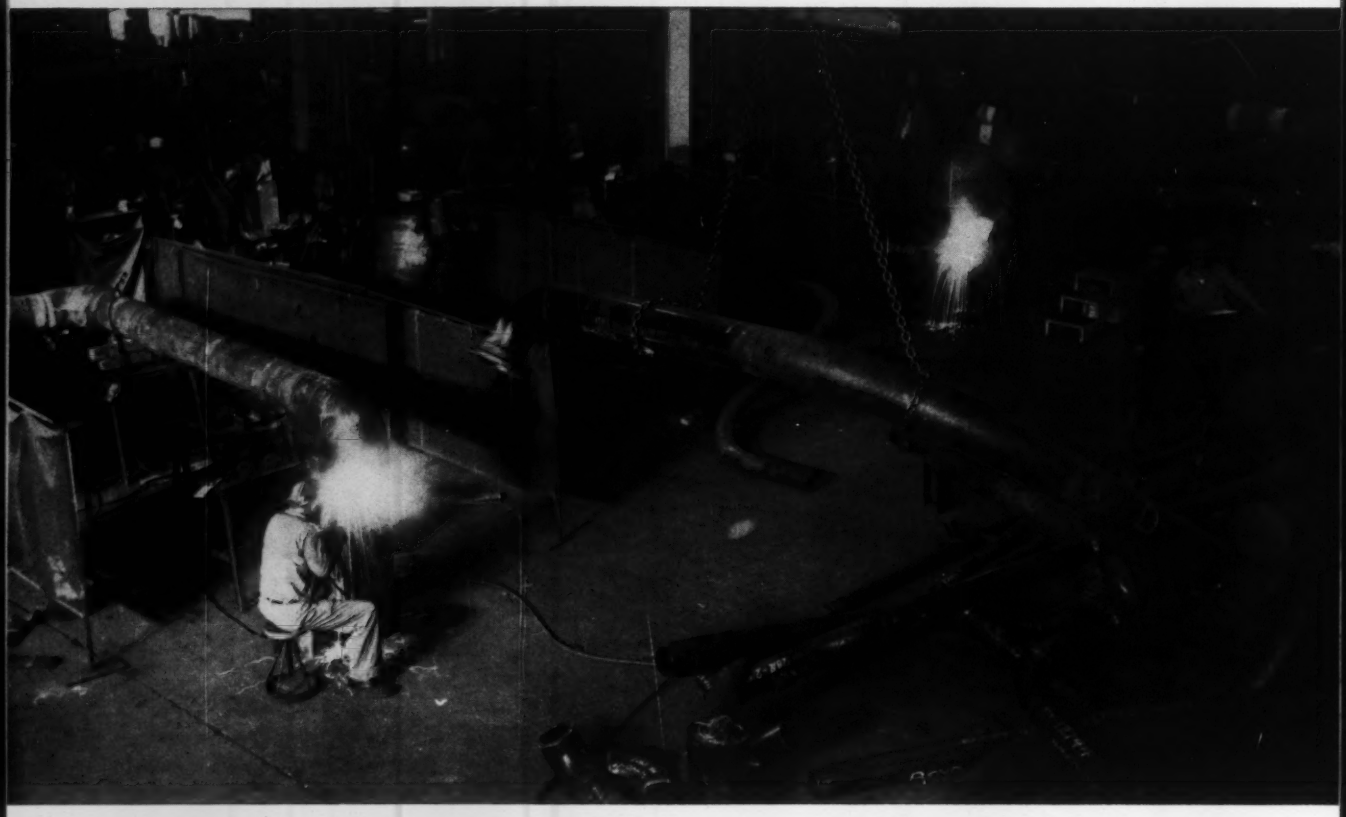
How Blaw-Knox cuts your power piping costs



121,000 square feet of space at your service. Power piping facilities at Pittsburgh include 56,000 square feet of plant area and an additional 65,000 square feet for exterior storage. An additional new plant is located on a 15-acre site in Jackson, Mississippi.

Your job is under the personal supervision of an experienced engineer, who follows your project from beginning to end. Your piping is handled with the most modern equipment for welding, heat treating, and bending. Fabricating techniques, proven by rigid testing, are used.

New product development. Blaw-Knox developed an enclosed type of functional spring hanger as part of their complete line of hangers for supporting any piping system. Here a group of hangers individually designed for a project is factory checked to assure fast field erection.

Stress calculation cut from months to a day . . . with pace-setting engineering. An exclusive Blaw-Knox method uses an electronic computer for automatic computation with no limitation on the complexity of system. Full accuracy, with tremendous savings in time and cost. Write for details.

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Power Piping Division
829 Beaver Avenue, Pittsburgh 33, Pennsylvania

Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

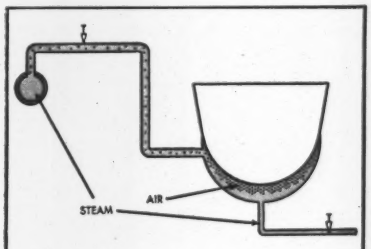


Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

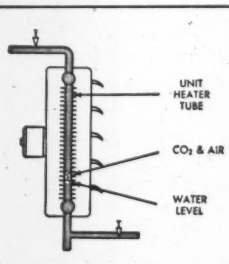


Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. CO_2 gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O_2 aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume)	
		10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4

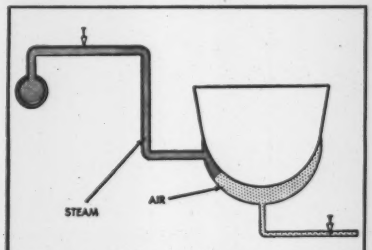


Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

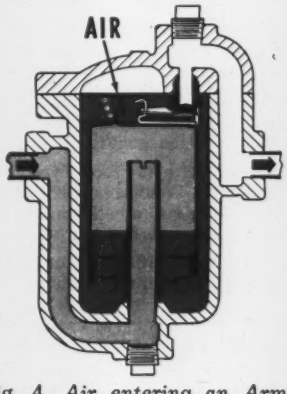
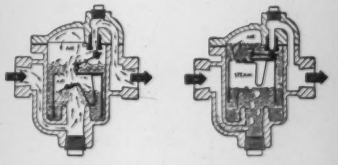


Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



Thermostatic vent open. *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8942 Maple Street, Three Rivers, Michigan.

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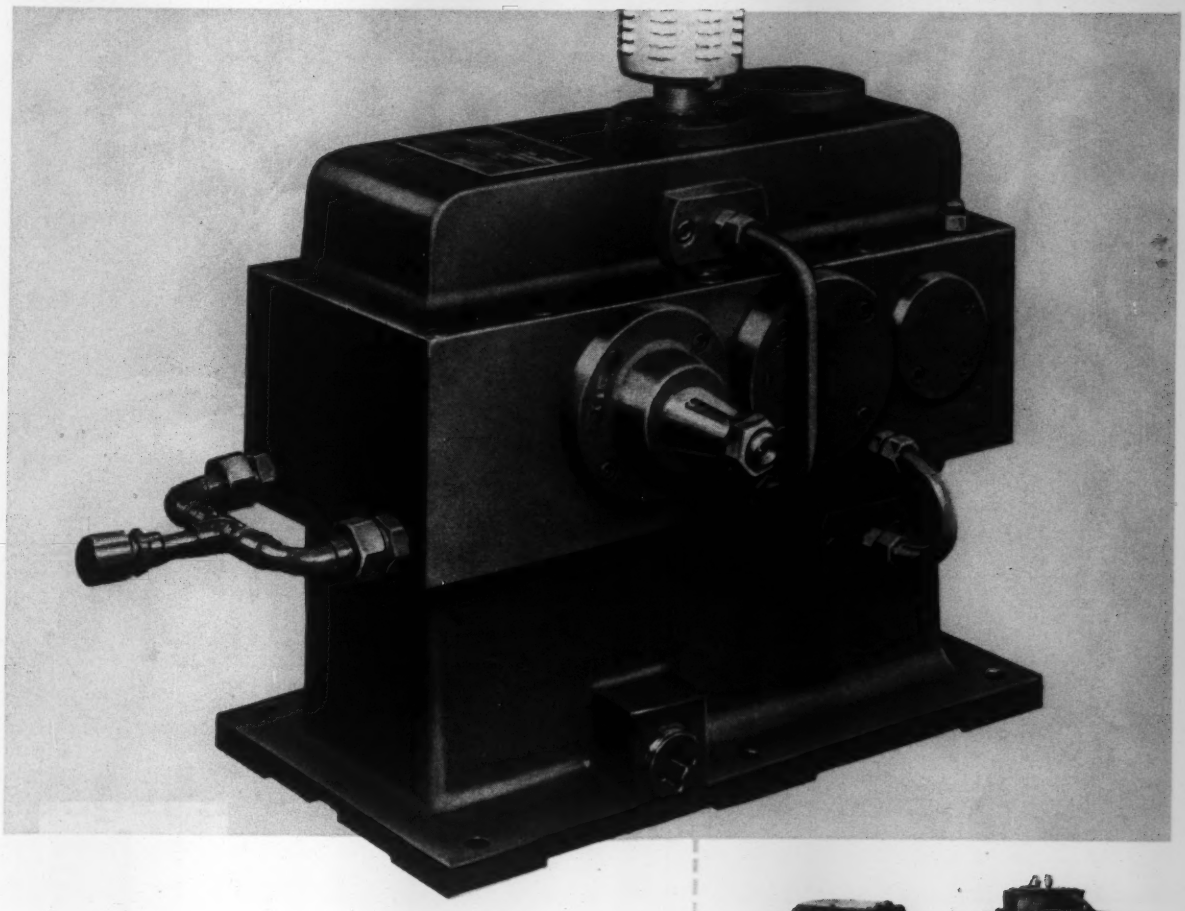
100,000 RPM FOR A TEST STAND



Another example of Farrel's ability to meet extraordinary gearing requirements

The speed increaser shown above—built for operation at 100,000 rpm—is only one of the scores of highly specialized test-stand units designed and built by Farrel. Three other examples are shown at the right. Each was individually engineered to customer requirements.

This experience offers virtual assurance of the ability to solve your high-speed gearing problems. The next time you need a test-stand unit, call Farrel. In the meantime send for a copy of bulletin 451.

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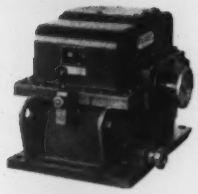
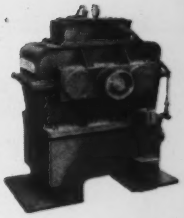
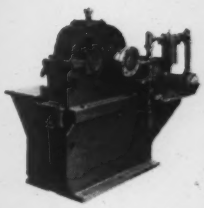


Special 375 HP speed-increasing unit, with two speed ranges, 6,000/10,769 RPM and 6,000/15,100 RPM.

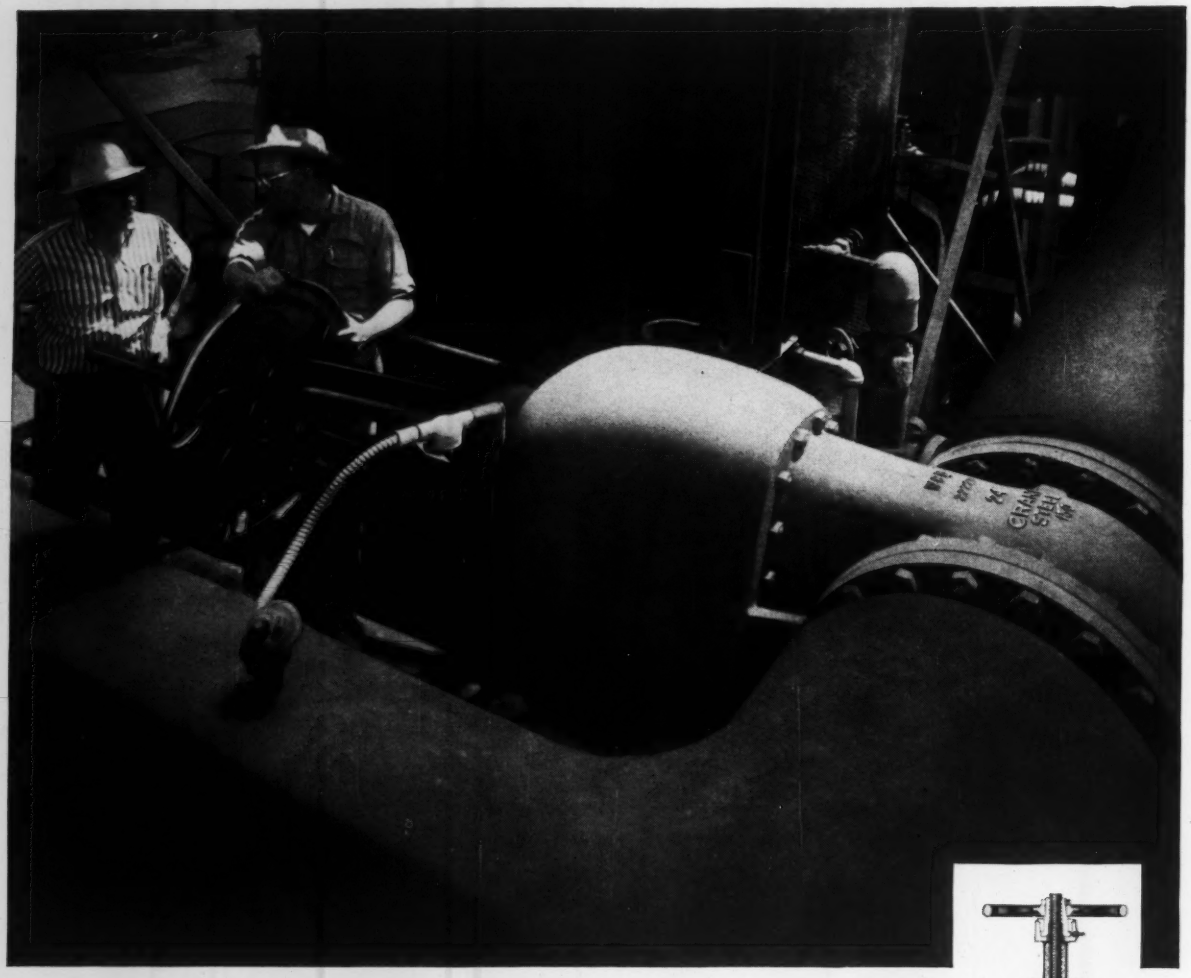


Special DD-9 speed-increasing unit, 660 HP, input speed range from 1,500 to 3,000 RPM, output speed range from 20,000 to 40,000 RPM.



Special SI-825 speed-increasing unit, 150 HP, 3,000 to 5,000 input RPM, with 3 gear-set ratios—1:7.971, 1:2.5091, 1:1.0127.

17 years' service vindicates engineers' choice of valve



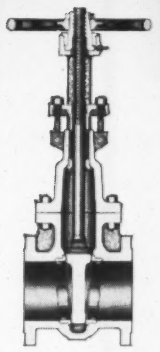
Crane 24″ gate handles 850° F. gases 17 years: no leaks...no maintenance

In 1942 Commercial Solvents Corporation, Sterlington, La., bought a hard-to-get Crane 24-inch, solid wedge disc steel gate valve.

At that time virtually all production was for national defense. Any down time for valve maintenance meant costly delays. So, this Crane valve was really on the spot—to justify its choice by plant engineers.

From the day the valve was installed to handle synthesis gas at 850° F. until today, the valve has not developed one leak. Nor has one cent been spent for maintenance. And the big 24-inch, hand-operated valve opens and closes as easily now as it did the day it went into service —17 years ago!

Measured in terms of production gains made possible by continuous, maintenance-free service, Crane quality-made valves more than pay for themselves. Ask your Crane Representative for quotations on any valves you need now.



The valve that's in its 18th year of service—Crane No. 47X, 150-pound, solid wedge disc steel gate. Available in 2 to 24 in. Other types for oil, oil vapor, steam, or water service for pressures up to 2500 pounds (and higher) and temperatures up to 1100° F. Your inquiry solicited. Write to address below.

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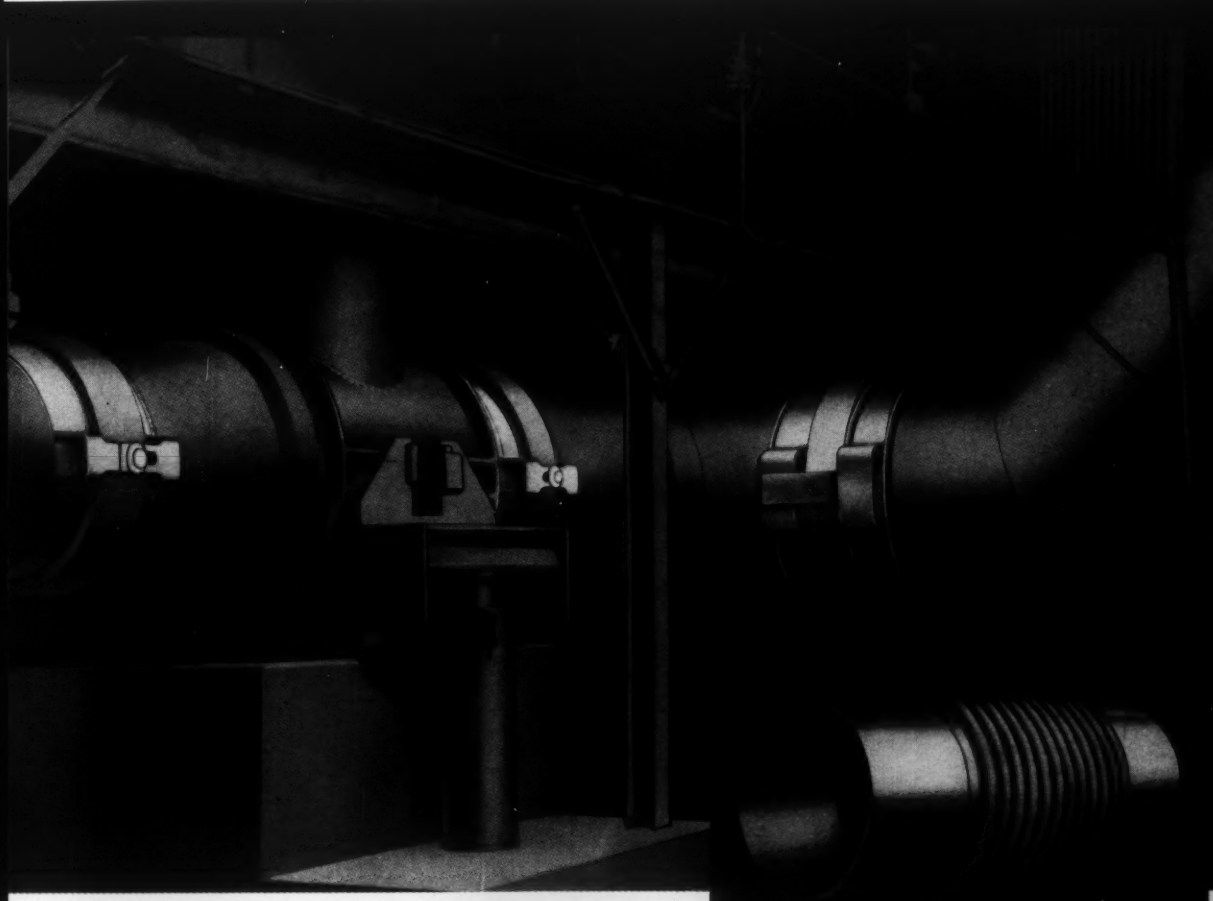


View of hydrocarbon outlet line just below reactors shows three of a total of 67 Badger S-R Expansion Joints at Firestone's new Butadiene Plant at Orange, Texas. Joints shown are equipped with guide bars and external covers.

Series 50W S-R Expansion Joint
Shown with cover removed

Badger S-R Expansion Joints handle rugged 1100° service at Firestone's new plant

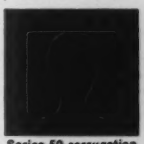
The Houdry process used at Firestone Tire and Rubber Company's new Butadiene Plant calls for temperatures up to 1100°. Add critical forces on anchors and connected equipment, wind loading, and complex piping arrangements and you have real problems in piping and expansion joint design.

Working together with Catalytic Construction Co. and Firestone, Badger solved these problems with new Service-Rated (S-R) Expansion Joints. In all, sixty-seven joints have been installed, all of the new Series 50 (low pressure) S-R design. Ranging in size from 30″ to 72″, the joints are arranged singly or in systems of hinged and tandem types to absorb and control pipe line movement (which, due to the piping arrangement, is often axial and lateral — in *two different directions*). Stainless steel bellows are used in all joints; welding nipples are stainless or carbon steel depending on temperatures to be encountered.

Here is another example of a severe pipe expansion problem Badger S-R Expansion Joints and engineering experience have solved successfully. Find out more about the ways they can help you — write today for illustrated brochure.

New corrugation and ring designs produce better equalization, "all-curve" flexing

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced... life increased.



Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer life.

Series 150 corrugation and ring cross-section

BADGER

S R

SERVICE RATED

EXPANSION JOINTS

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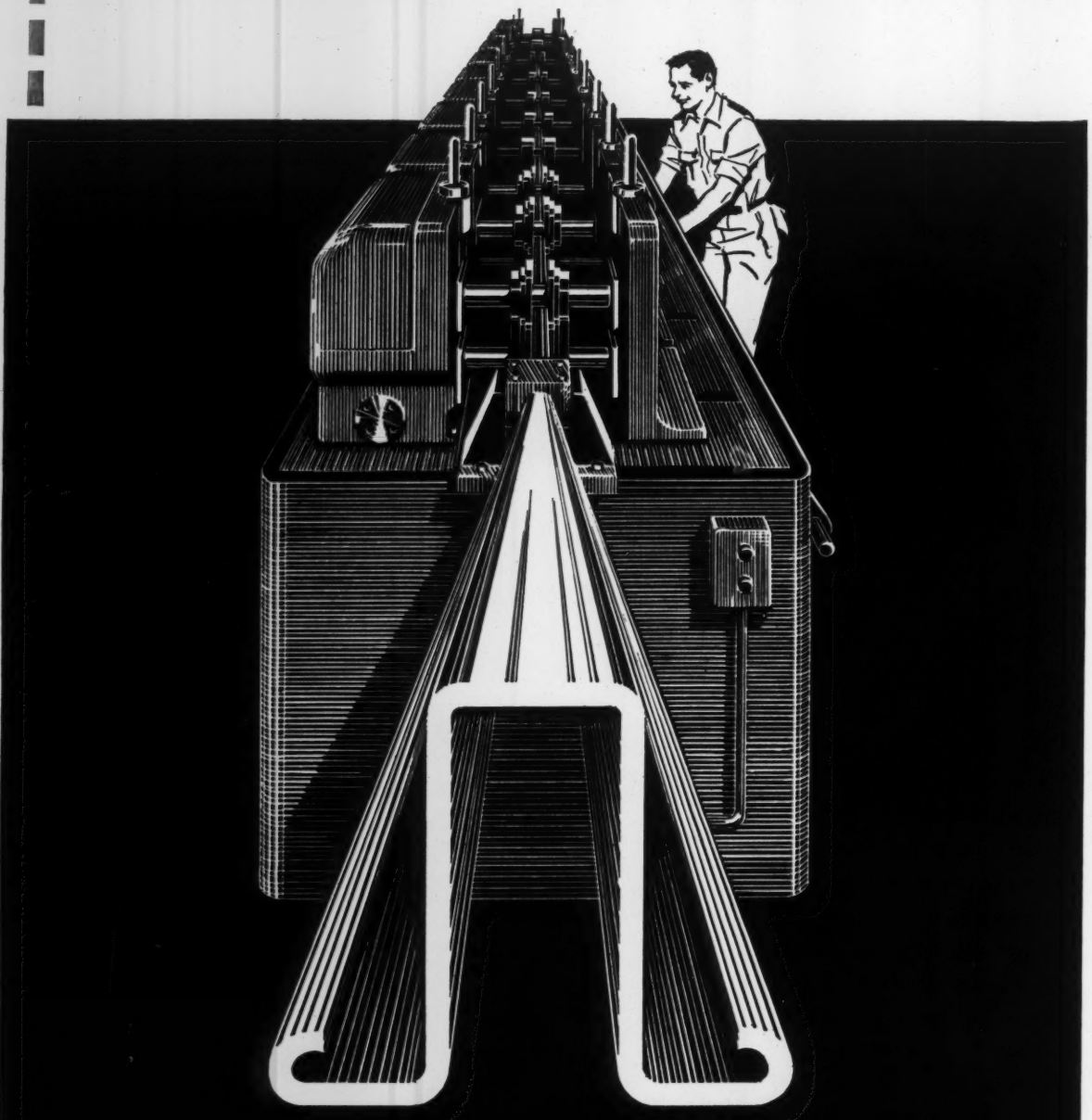
BADGER MANUFACTURING COMPANY
230 Bent St., Cambridge 41, Mass. • 60 East 42nd St., New York, New York
Representatives in Principal Cities

YODER

Roll Forming Equipment—Product dependability—integrity of manufacture—engineering for specific production needs have all contributed to establish Yoder equipment as the industry standard of excellence. Since 1909 Yoder-built machinery, including Pipe and Tube Mills, Roll Forming Equipment and Rotary Slitters, have earned world-wide customer satisfaction and recognition. Profit from Yoder's years of engineering and service experience. Send today for the illustrated Yoder Roll Forming Equipment Book.

THE YODER COMPANY • 5499 Walworth Avenue • Cleveland 2, Ohio



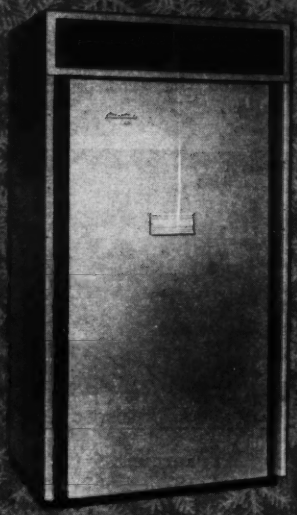
ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

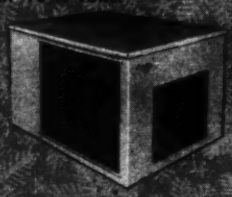
Curtis

CONDITIONS COMMERCIAL AMERICA

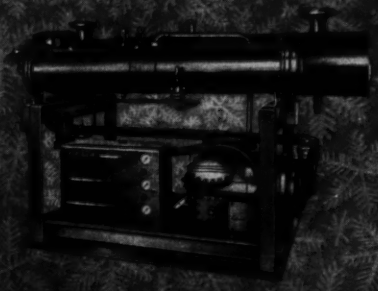


Curtis packaged units minimize floor area required. Factory assembled and tested. Field installation requires only setting and connecting utilities.

PACKAGED AIR CONDITIONERS UP TO 30 TONS



AIR-COOLED UNITS UP TO 10 TONS



PACKAGED LIQUID CHILLERS UP TO 100 TONS

PRECISION

close tolerance manufacturing, builds peak performance into every CURTIS unit.

Curtis is the "luxury line" in the air-conditioning industry. Silence, efficiency and long-life are inherent in Curtis design.

Yet Curtis prices are right in line.

This is why Curtis designs and builds thousands of unique air conditioning systems for commercial America . . . why Curtis is able to maintain a family of over 300 representatives and servicing contractors across the nation.

Put the advantages of CURTIS PRECISION into your next job.

Curtis

MANUFACTURING COMPANY
REFRIGERATION DIVISION

OUR 105th YEAR

WRITE DEPT. 8, ST. LOUIS 20, MISSOURI

THE CURTIS "LUXURY LINE" OF AIR CONDITIONERS COSTS NO MORE

rigid specifications

Tension tests are required to be made at room temperatures and at 670° F. The following minimum physical properties shall be met:

At Room Temperature:

TS	YS	EL	RA	CHARPY V-NOTCH
70,000	30,000	45	50	50

At 670° F. the minimum tensile strength shall be 51,000 p.s.i. and the minimum yield strength 18,300 p.s.i.

Rejection

Each casting that develops unacceptable defects during shop working or fails to conform to all of the requirements of these specifications shall be rejected. No repair by welding or other means will be permitted.

All cast pipe shall be hydrostatically tested to 5,900 p.s.i. and held at that pressure for 20 minutes with zero pipe leakage. Each length of pipe shall be hydrostatically tested at the manufacturer's plant.

Radiographic Inspection

(a) Paragraph S5 (a) of the Supplementary requirements of ASTM-A 362-52T.

(b) All castings shall be radiographed 100% and shall conform to ASTM-E7 1-52, Class 2 quality, except as modified by these specifications.

(c) The manufacturer shall establish a positive system of identification of the X-ray plates which shall be subject to approval by the inspector. This system shall guarantee complete coverage by radiographing and provide for positive identification between the plate and the subject.

Inspection of Penetrants

All castings shall be subjected to inspection by fluorescent penetrants or penetrating dyes both inside and out. All cracks, porosity, or flaws revealed as a result of the Dye Penetrant Test shall be due cause for rejection of the casting.

The 304L stainless steel shall conform to the following ladle analysis:

Carbon	.03 max.		
Manganese	1.50% max.		
Phosphorous	.03% max.		
Sulphur	.03% max.		
Silicon	2.00% max.		
Chromium	18.00	-	21.00%
Nickel	8.00	-	11.00%

Pipe: All pipe of the following sizes shall be centrifugally cast stainless steel as per ASTM-A 362-52T, except as modified by these specifications:

16" - Sch. #160
12" - Sch. #160
10" - Sch. #160
8" - Sch. #140

All pipe shall be machine finished to 125 micro-inch interior and exterior.

for nuclear piping met by U.S. PIPE metal mold process

Centrifugally Cast Stainless Steel Solves Many Piping Problems

Combinations of temperatures, pressures and corrosive conditions never encountered before: these are among the piping problems that must be overcome by the men who design the nation's nuclear power installations.

Stainless steel centrifugally cast pipe provides many of the answers. Study the specifications at the left . . . specifications demanded of stainless steel pipe on a recent job for Paul Hardeman, Inc., Los Angeles, California. This pipe is being used for heavy duty, high pressure, elevated temperature service in the primary piping system of the SPERT-III Reactor at the U. S. Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho. The Stearns-Roger Mfg. Company, Denver, Colorado, is the architect-engineer on this project. A complete tabulation of the actual test data obtained on this pipe and to this specification is available upon request.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses—in large and small quantities—and to individual specifications.

If piping of the type described above is the bottleneck in your nuclear power planning, write and outline the problem.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—¾" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

BURLINGTON, NEW JERSEY

STEEL & TUBES U.S. PIPE DIVISION

SALES OFFICES: BURLINGTON, BOSTON, CHICAGO, CLEVELAND, LOS ANGELES, NEW YORK, PITTSBURGH, SAN FRANCISCO, ST. LOUIS

OZALID announces an important advance for microfilm users!

Here's a major event in the microfilm field!

Now, a new source of microfilm is available to industry. Developed by Ansco in close association with Ozalid experts, this fine-grain, high-resolution film assures crisp, sharp rendering of detail with consistent results. What's more, this new microfilm is capable of resolving 200 lines per mm. which exceeds the exacting requirements in microfilming for engineering, industrial, governmental, and military specifications.

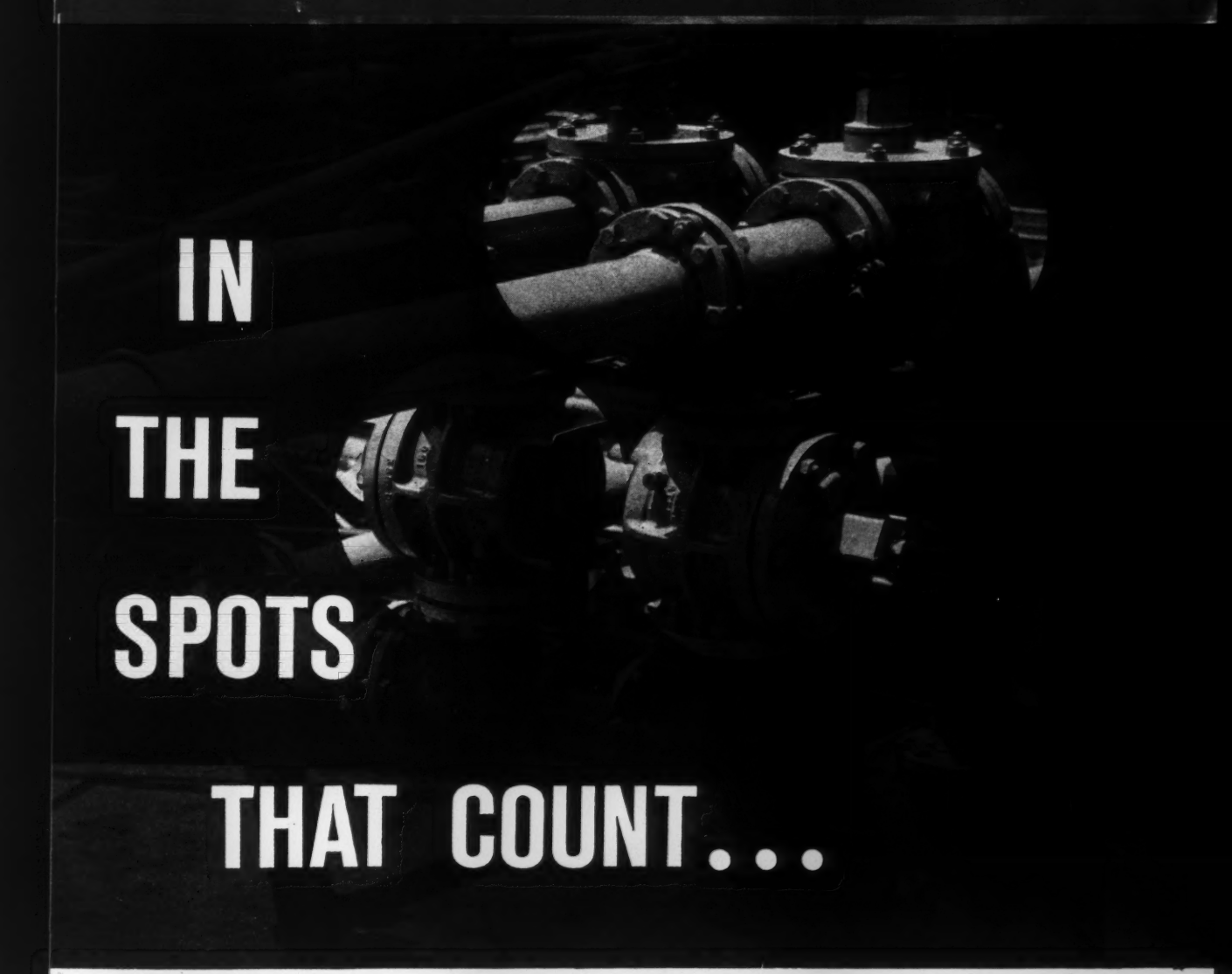
Ozalid, the name synonymous with engineering drawing reproduction, now offers *the most complete microfilm product line* available for the engineering field and for planetary camera applications . . . everything from film to a complete selection of cameras, readers, processors, and related supplies.

Write today for the name of your nearest Ozalid microfilm specialist. He'll be glad to demonstrate the exciting advantages of the Ozalid *one-source* product line. Write: Microline Products, Ozalid, Dept. U-4, Johnson City, N. Y.

Available in 16 mm. in 100, 200, and 1000 foot lengths;
in 35 mm. in 100 and 1000 foot lengths.

OZALID®
microline

Microline Products, Ozalid Division of General Aniline & Film Corp.
Microline in Canada, The Hughes-Owens Company, Limited, Montreal.

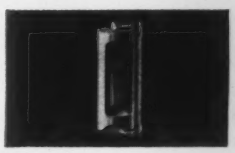


Goodyear specifies Homestead Valves for non-contamination of GR-S latex rubber

Through the round ports of Homestead Lubricated Plug Valves at Goodyear Tire and Rubber Company's synthetic rubber plant in Houston, Texas, flow dilute solutions of GR-S latex rubber at 80 p.s.i. and 100° F.

Fluid solutions never lodge and build up in the line since Homestead Round Port Valves provide full circular opening through plug and body of the valve —same size as the pipe they serve.

A letter or the coupon below will bring you further information on this installation. You may also receive complete details on low first cost, low maintenance, Homestead Valves in our catalog 39-1.



Controlled pressurized lubrication plus extremely close tolerances between plug and body assure lubrication of all sealing surfaces without contamination of line fluids.

hv

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box 38, Coraopolis, Pennsylvania

☐ Please send me catalog and prices on Homestead Lubricated Plug Valves.
☐ Send more facts about latex applications.

Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

For the first time!

Everything you need in Dial Thermometers for Piping *and* Duct work!

A new and complete line of instruments: Dial thermometer of Marsh precision and accuracy designed down to the last detail for piping and duct work . . . for use on heating and cooling equipment, air ducts, vessels and kilns, ovens and similar applications.

Easier to read

Illustrations tell the story. Four types, seven ranges—72 stock combinations to meet every condition. Big, legible 3½" and 4½" dials . . . easy to read in places where piping and duct thermometers must be installed. Ease of reading further increased by provision for tilting and turning dials to any desired reading angle. Line includes distant reading types that take care of remote locations.

Unbreakable—more accurate

Instead of fragile difficult-to-read glass tube thermometers you now have sturdy, unbreakable, legible Marsh Dial Thermometers. Guaranteed accurate to plus or minus one division of the scale, they have far greater *readable* accuracy than any glass tube type. All have the famous Marsh "Recalibrator"—to *keep* them accurate.

All purpose

Design provides for every on-the-job condition. Separable sockets ("wells") simplify installation—or removal for servicing. Extension necks take care of insulation on piping or ducts. Long stems in duct type put temperature-sensitive section where it belongs.

Note the brief specifications opposite. Any thermometer is available from stock.

Write for bulletin telling the whole story.

Jas. P. Marsh Corporation
Dept. 29, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd Street, Edmonton, Alberta

For piping

Dial sizes: 3½" and 4½"

Ranges:
0° to 100°F for chilled water
20° to 120°F for condenser water
40° to 240°F and 100° to 300° for hot water and domestic water

¾" NPT connection

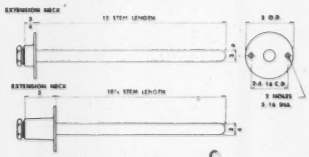
All ranges, in both direct mounted and remote reading types, available with three standard sockets shown in drawing below.

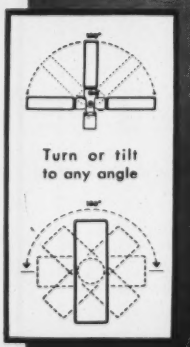
For ducts

Dial sizes: 3½" and 4½"

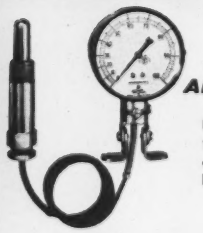
Ranges: −40° to +120° F
0° to 160° F
0° to 220° F

All ranges, in both direct mounted and remote reading types, available with standard extension necks and stems shown in drawing below.



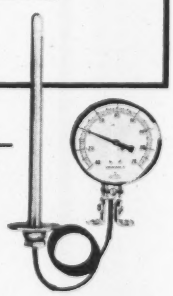


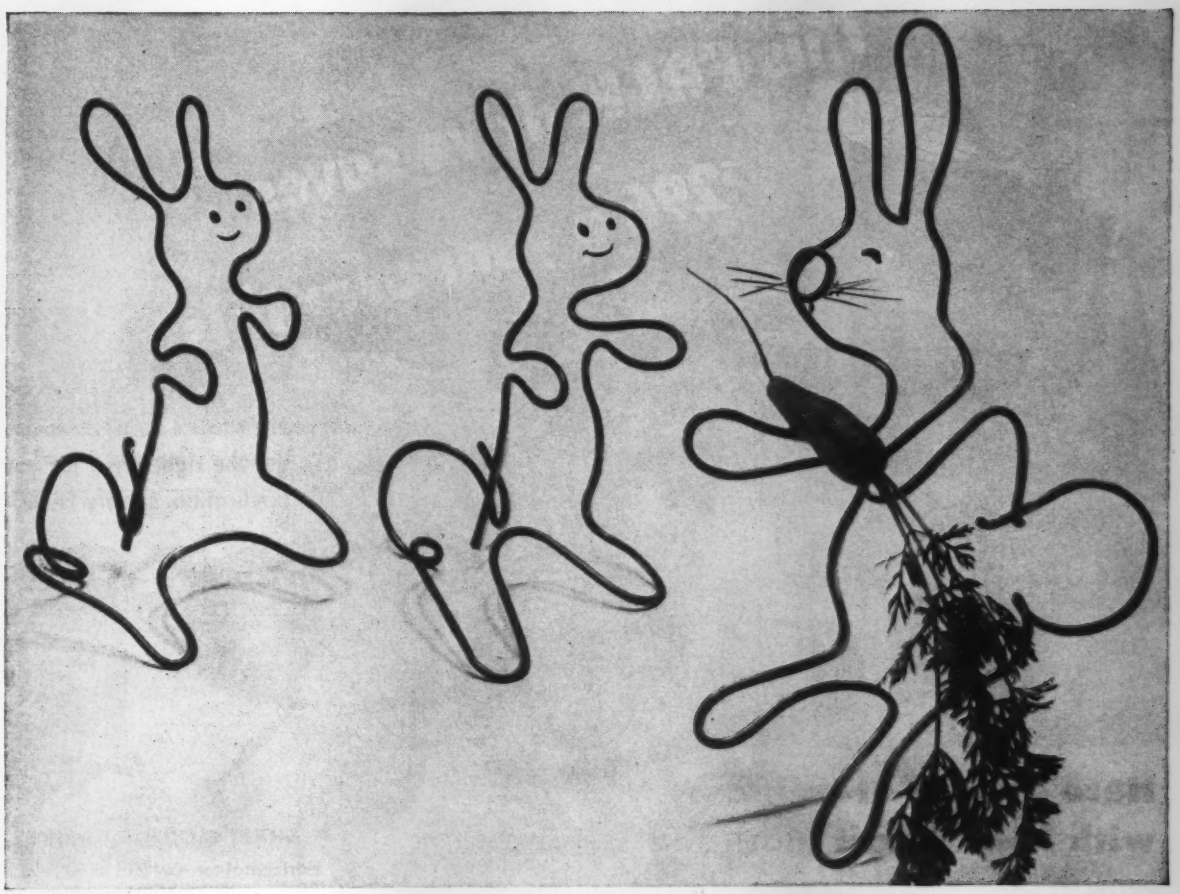
MARSH
DIAL THERMOMETERS



Also remote reading—

Piping and duct thermometers of same basic design available with 6 ft. of capillary tubing as shown.





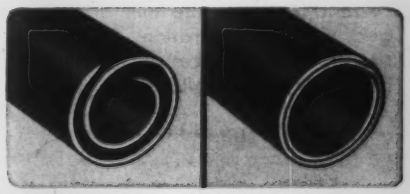
There's practically no limit to the things Bundy can mass-fabricate

. . . and we do it with Bundyweld, the stronger, safer steel tubing that's made for easy bending

SKILLED Bundy® technicians turn out many a strange shape—each to its exact tolerances. At Bundy, you get precision *in mass-fabrication.* Jigs, fixtures—even machines—are designed by Bundy specifically to cut customers' unit costs.

You get Bundyweld® Tubing, too. An exclusive process (right) gives it unique physical properties. So Bundyweld—master of volatile refrigerants and high-pressure brake fluids—has become the safety standard of two major industries.

Bundy engineers will design your tubing part, or work with you on its development. When we fabricate your parts, you can count on careful packaging, on-time delivery. Bring *your* tubing problem to Bundy. Contact us today!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

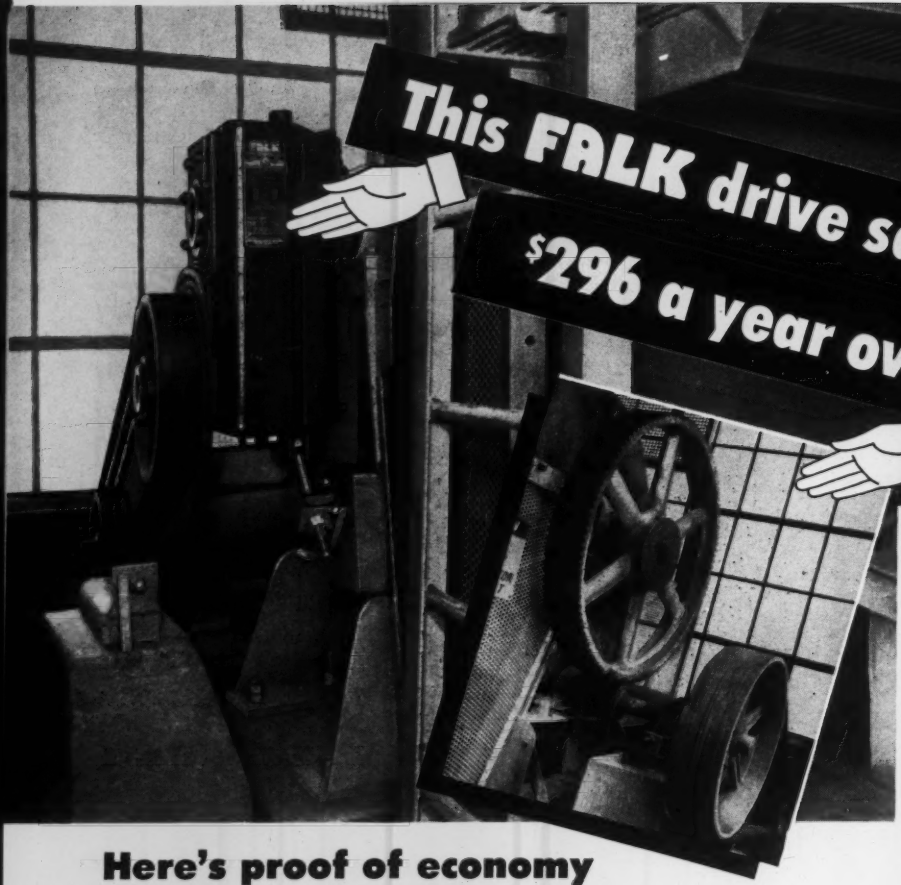
Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no real substitute for Bundyweld Tubing

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY



Here's proof of economy with FALK Shaft Mounted Drives

PROBLEM—For many years, a prominent Eastern abrasives manufacturer* experienced high maintenance and down-time costs, as well as excessive noise and vibration, in the operation of 19 pebble mills driven by open spur gears. Drive gears and jack shaft pillow blocks required frequent repairs or replacement, and trunnion shafts often failed, due to radial overloading of the bull gear when broken pinion teeth bottomed between gear teeth.

SOLUTION—After numerous unsuccessful approaches to these problems, the solution was found by mounting a Size 315J FALK Shaft Mounted Drive directly on the mill drive trunnion. This eliminated objectionable gear noise and vibration...greatly reduced costly down-time and loss of production...and cut annual maintenance and replacement expenses as indicated by the following figures taken from the customer's records:

Spur Gear-and-Pinion Drive		FALK Shaft Mounted Drive	
Bull Gears	$ 56	VEE Belts	$ 30
Pinions	120	FALK Shaft Mounted Drive (based on 10-year life)	70
Pillow Blocks	90		
VEE Belts	30		
Trunnion (5-year life)	100		
Annual cost	$396	Annual cost	$100
		ANNUAL SAVINGS	$296

IF OBSOLETE DRIVES ARE COSTING YOU MONEY, a change to Falk All-Steel Shaft Mounted Drives can effect important savings in money and production. Used on almost any type of machine, these compact, rugged units are establishing new standards of economy and efficiency in many industries. Specify FALK Drives on your purchased equipment...For full details, **write for Bulletin 7100.**

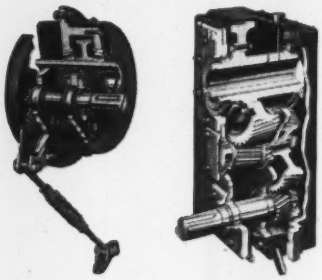
*Name on request

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in Most Principal Cities

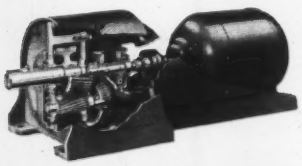
To get the right drive for your application, specify FALK®



SHAFT MOUNTED DRIVES

Horizontal or vertical units—½ to 50 hp—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 41,000 lb-in (consult factory for higher torque capacity).

• • •



ALL-MOTOR® MOTOREDUCERS

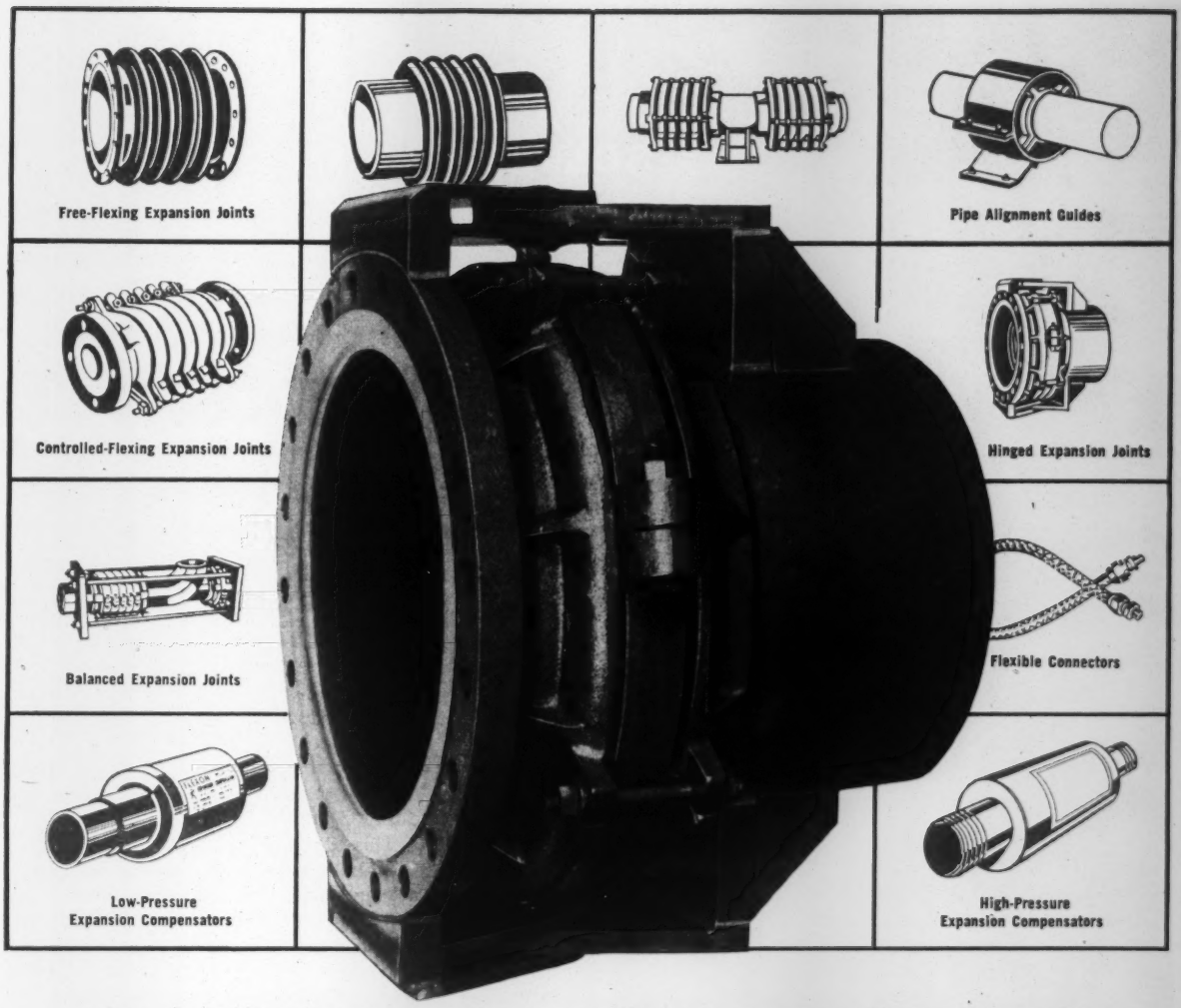
Sizes up to 75 hp—furnished with or without standard foot-mounted motor—standard output speeds 1.2 to 520 rpm (with 1750 rpm motors)—ratios as high as 54,000:1 in semi-standard designs. Integral units (gearmotor type) also available. Ask for **Bulletin 3100.**

• • •

FALK Drives are available from factory and distributor stocks from coast to coast. Consult your Falk Representative or Distributor.

FALK

...a good name in industry



THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

For hinged or any other type of standard or special expansion joints — your best bet is FLEXONICS. Here's where you'll find the equipment, the experience, the skill to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from five FLEXONICS warehouses. They all add up to expansion joints that you can *install and forget* — plus expansion compensators, flexible connectors, the all-new FLEXONICS pipe alignment guides and other piping accessories.

Today—write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

Member Expansion Joint Manufacturers Association

EJ-240

TOMORROW'S ENGINEERING TODAY

Flexonics

EXPANSION JOINTS

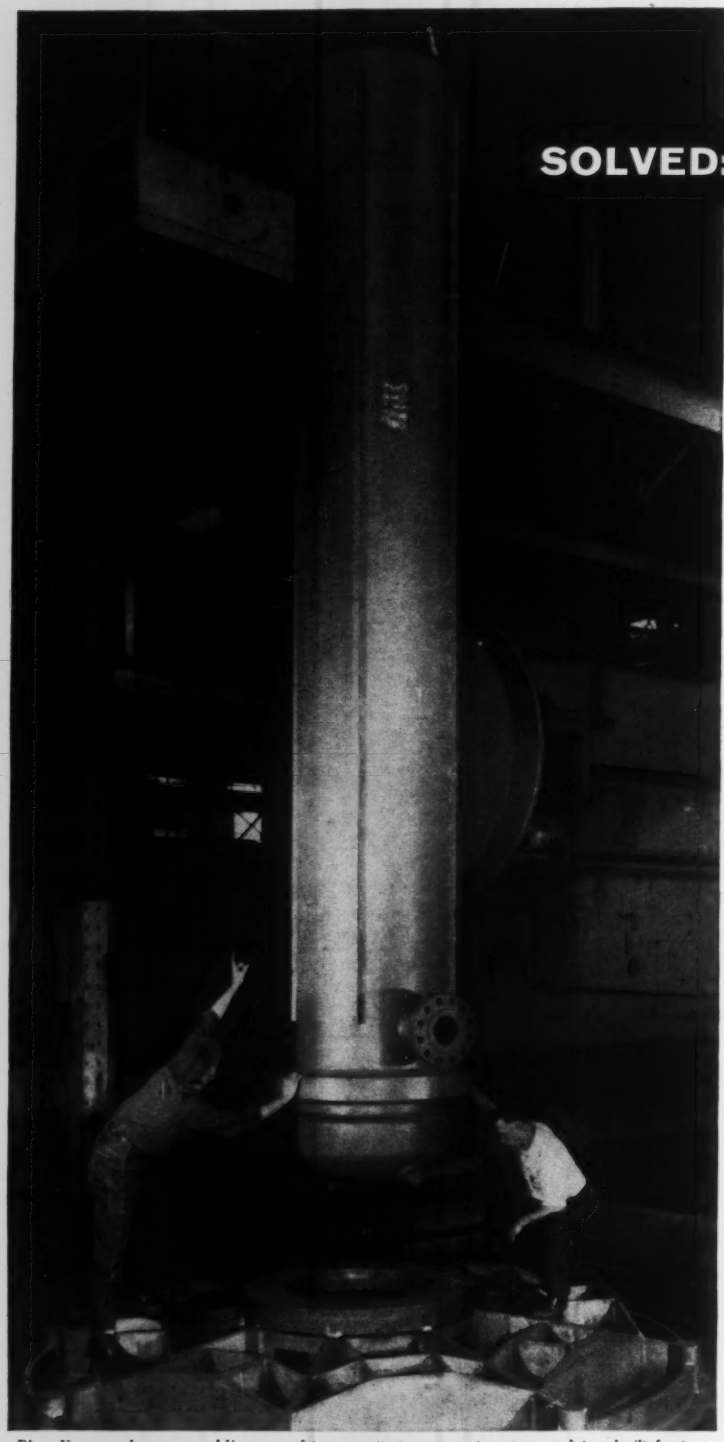
FLEXONICS CORPORATION • 1305 SOUTH THIRD AVENUE • MAYWOOD, ILLINOIS

Divisions

INDUSTRIAL HOSE • EXPANSION JOINT • BELLOWS • AERONAUTICAL • AUTOMOTIVE

Flexonics Research Laboratories, Elgin, Illinois

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario



Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton

SANDUSKY CASTING

for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

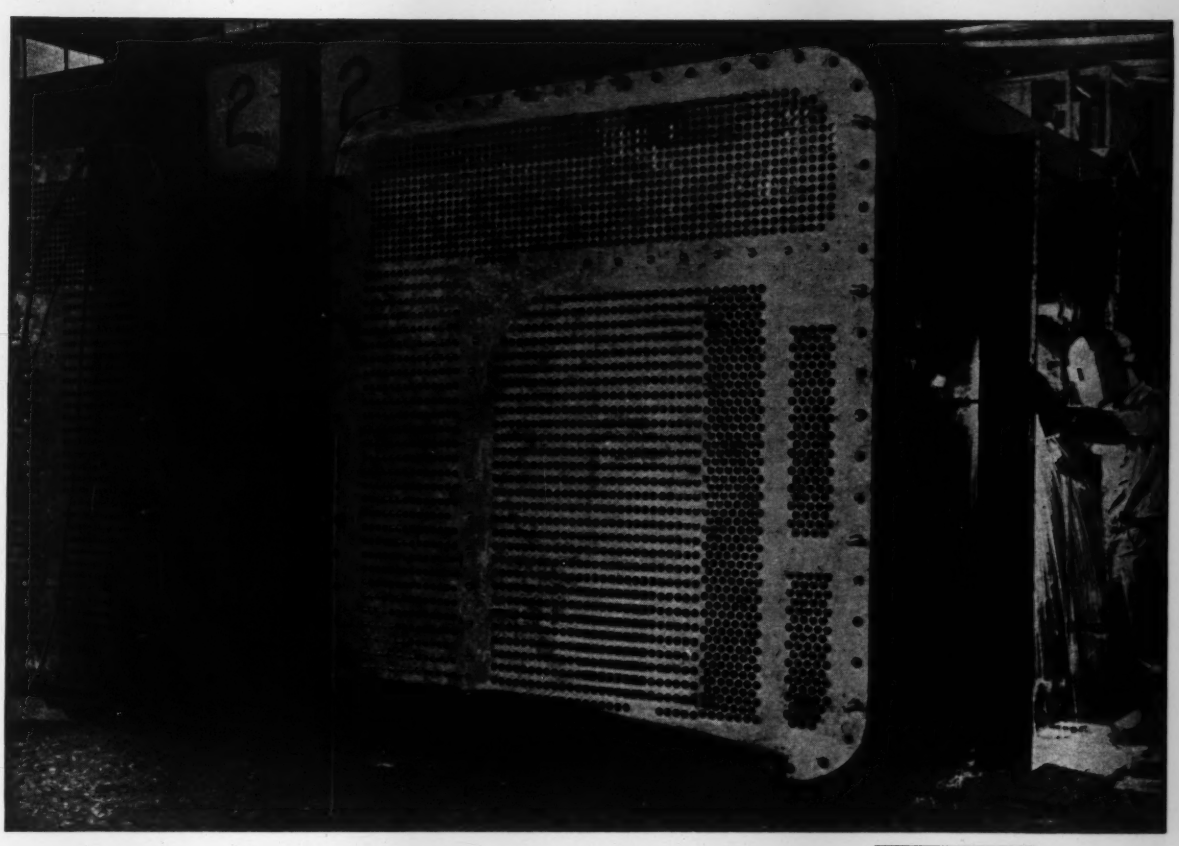
Write to us at Sandusky, Ohio. Ask for latest Bulletin #200.

SANDUSKY CENTRIFUGAL CASTINGS

FOUNDRY & MACHINE CO.

8901

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys



C.H. Wheeler Reverse Flow Condenser prior to installation at Savannah Electric & Power Company's Riverside Station. Reverse Flow principle could save Savannah hundreds of dollars: leaves, twigs, algae and other foreign matter can be flushed from tubes and tube sheets without shutting down the unit.

BECAUSE Reverse Flow design eliminates hours of costly down time

C.H. WHEELER CONDENSERS SAVE YOU MONEY

Let's suppose the condenser tubes and tube sheets in your station become clogged. If your condenser is of conventional design and serves a 200,000 kw turbine, you'd need many hours to clean the tubes, and each hour you spend could cost as much as $330!*

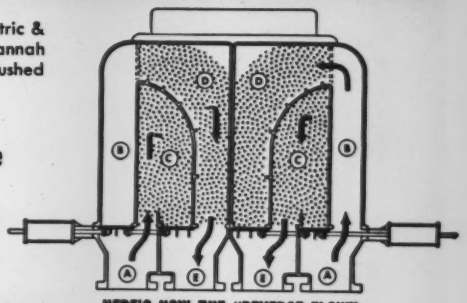
But with C.H. Wheeler's Reverse Flow design, you could flush away debris in a few minutes without shutting down the Condenser!

Reverse Flow is only one of the features of C.H. Wheeler Dual Bank Surface Condensers which save you money. Other money-saving features which result from Wheeler's 55 years experience in designing and building Condensers and auxiliaries, include better tube sheet design and advanced engineering of Tubejet® Steam Jet Ejectors, Condensate Pumps and Circulating Pumps.

*Based on an estimated cost of $8,000 per day for shutdown of a 200,000 kw Turbine-Generator.

C.H. WHEELER SAVES YOU MONEY IN THESE WAYS, TOO

- Pure condensate
- Lower absolute pressure, higher vacuum
- "Zero" condensate temperature depression
- Deaeration to 0.03 cc. of oxygen per liter. (Special design provides for deaeration to 0.01 cc. per liter.)



HERE'S HOW THE "REVERSE FLOW" PRINCIPLE WORKS

Left Side Shows Normal Operation: Water enters inlet A with right port open, flows through tube bank C to rear of condenser; then it returns through tube bank D to front of condenser and discharges at point marked E.

Right Side Shows Reverse Flow: Sluice gates move on a common stem. Water flows up through channel B, through tube bank D to rear of condenser; returns through bank C to front of condenser.

In the C.H. Wheeler Divided Water Box design each half of the condenser can be back-flushed independently of the other; or both halves can be back-flushed simultaneously, with one or two circulating pumps operating.

C.H. WHEELER MFG. CO.

19th and Lehigh Avenue • Philadelphia 32, Pennsylvania

Whenever you see the name C.H. Wheeler on a product, you know it's a quality product.

Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

CLARAGE

ARCHITECTS:
Harrison & Abramovitz, New York, N.Y.; A. G. Odell, Jr., & Associates, Charlotte, N. C.
ENGINEER:
Jaros, Baum & Bolles, New York, N.Y.
GENERAL CONTRACTOR:
J. A. Jones Construction Co., Charlotte, N.C.
MECHANICAL CONTRACTOR:
Hicks & Ingle Co., Charlotte, N.C.

Another outstanding new building uses Clarage Fans

WACHOVIA BANK & TRUST COMPANY

Attractive — both inside and out — is this newcomer to the Charlotte, North Carolina skyline.

Concrete "curtain walls" give the exterior a distinctive beauty; Clarage Fans give the interior a pleasant atmosphere.

Chosen for the air handling assignment were ten Clarage Type NH system fans and eight Clarage Ready Unit ventilating sets. Prompting this selection: Clarage's recognized ability to perform quietly, economically, *dependably.*

Make sure your investment in air handling and conditioning equipment is a profitable one. Investigate the *quality* line we manufacture for buildings of all types, all sizes.

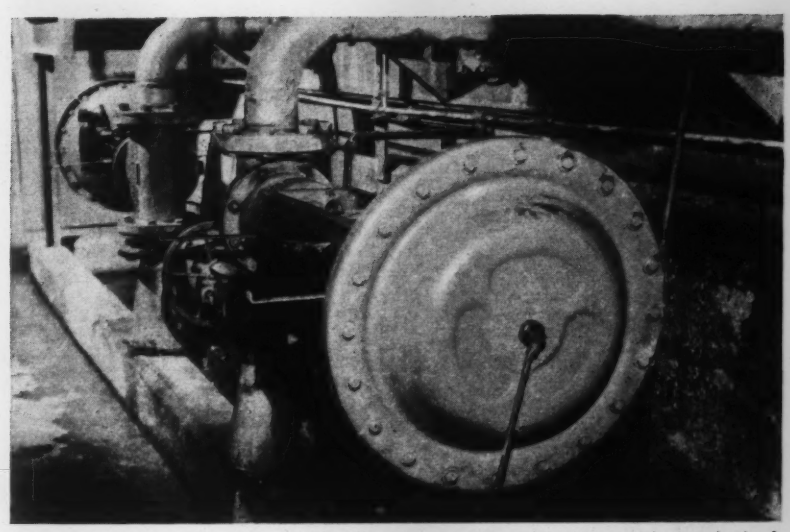
Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

Found:
a valve responsive to sensitive instrument control, with low maintenance



Grinnell-Saunders Straightway Diaphragm Valves on back of Trimbey meter on Mead Corporation's No. 10 paper machine.

Grinnell-Saunders Straightway* Diaphragm Valves were originally selected by Mead Corporation for stock level control at its Chillicothe, Ohio paper making plant. Mead's instrumentation specialists wanted a valve which would provide fine control in response to sensitive instruments.

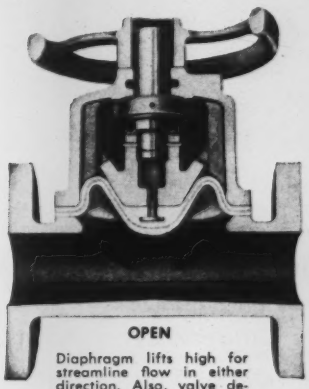
Because these Straightway Valves also avoid difficulties from clogging, stringing and dewatering as well as leakage, plugging, sticking and erosion, they have since been specified for other services throughout the plant.

Grinnell-Saunders Straightway Diaphragm Valves solve tough problems in many piping systems. They provide special benefits in lines handling corrosive fluids, viscous material, fibrous slurries, sludges, solids in suspension and semi-fluid materials.

These highly efficient valves provide streamlined flow, positive closure, complete isolation of operating mechanism, minimum maintenance, interchangeability of parts, manual or power operation, and a choice of body lining and diaphragm materials.

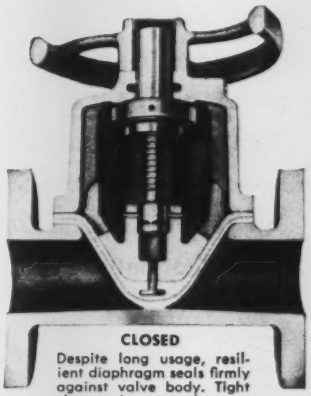
For complete information on straightway or standard weir types, handwheel, lever, or power operated, write Grinnell Company, Inc., 277 West Exchange Street, Providence 1, Rhode Island.

*PATENTED



OPEN

Diaphragm lifts high for streamline flow in either direction. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED

Despite long usage, resilient diaphragm seals firmly against valve body. Tight closure is assured, even when handling gritty or fibrous materials.

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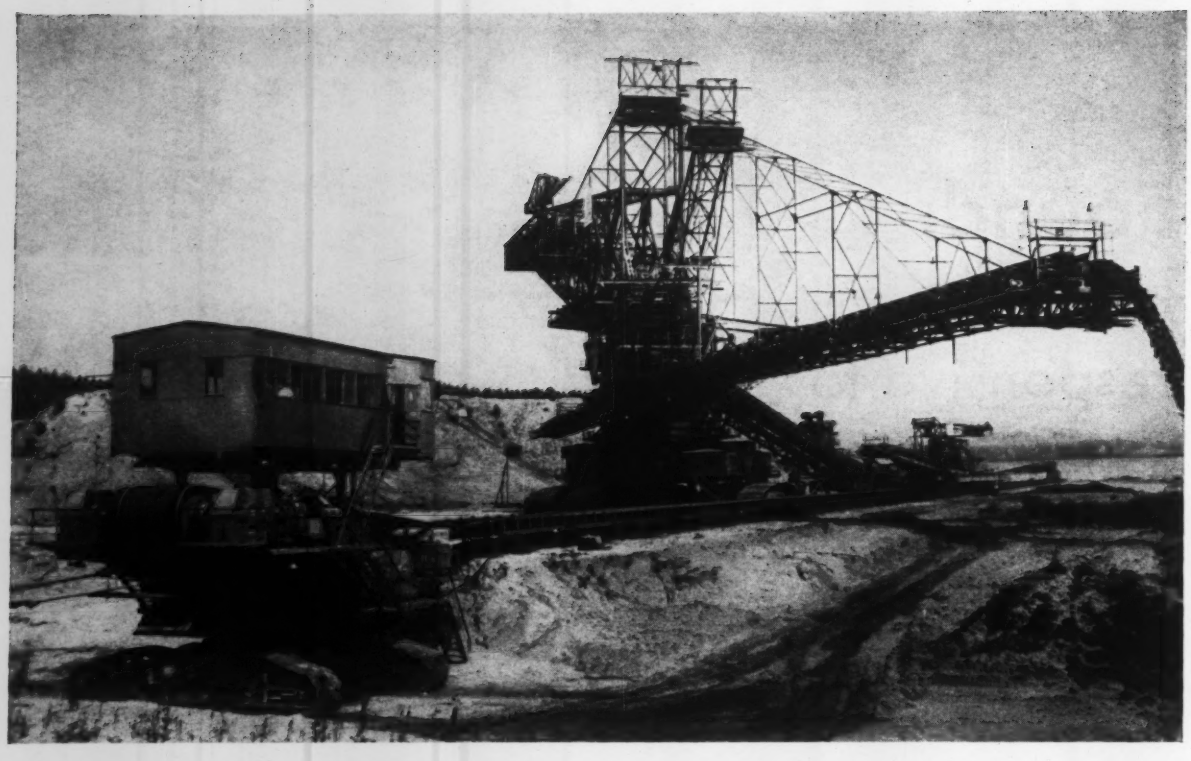


New Overburden Handling System

Stripped overburden arriving by rail is discharged into a trench and reclaimed by a bucket-wheel loader. A system of movable and stationary conveyors transports the reclaimed material to a giant boom stacker which dumps it into the worked-out area. Belt tripper, boom stacker, and the drive unit of the movable conveyor are mounted on crawler tracks. Daily capacity 130,000 cu.yds. of natural soil.

Bucket-wheel Loader
Gantry design
Rail mounted
Bucket-wheel dia. 41 ft.
Bucket capacity 4.7 cu.yds.
Slewing bank-sloping attachments

Boom Stacker
Dumping above and below track level
Length of boom 110 yds.
Belt speed 21 ft./sec.
Boom swing 220°
Freely suspended pickup boom

Conveyor System
Stationary conveyor
Length 660 yds.
Belt width 7.2 ft.
Belt speed 15 ft./sec.
Horsepower 1650 hp
Movable conveyor
Length 660 yds. (1700 yds. in future)
Belt width 6.5 ft.
Belt speed 19 ft./sec.
Horsepower 2200 hp (3300 hp in future, incl. tail pulley drive)

FRIED. KRUPP MASCHINEN- UND STAHLBAU RHEINHAUSEN

MECHANICAL ENGINEERING

VOLUME 81 • NUMBER 4 • APRIL, 1959

Too Many Meetings?

At the ASME Technology Executives Conference held at Arden House, Harriman, N. Y. (MECHANICAL ENGINEERING, March, 1959, pp. 120–122), a point of discussion that received great attention dealt with the multiplicity and duplication of technical meetings.

Questions: Are too many meetings being held in similar fields? Are the same or like papers being presented in various forms at peripheral interest meetings?

One school of thought maintains that there are too many meetings in a similar field. This, it is said, results in a drain on the valuable time of company personnel who are expected to attend meetings that are of the utmost interest to them. Of course, their time is well spent if the papers and reports are new or bring their field of technology into focus. But, it can be extremely frustrating to go to a meeting and find that much of the material is repetitive, given by the same author, and oftentimes under the guise of a new title. This happens, and perhaps, all too often.

On the other hand, what may seem to be duplication may not be the case at all. For example, engineering societies, trade and manufacturers associations, and other organizations all may be operating within the sphere of a specific field. All will schedule meetings and all these meetings may appear to cover the same subject. However, there are differences. Engineering society meetings are geared to cover the highly technical and theoretical aspects of the subject of prime interest to the practicing engineer; the association meetings are slanted, in most instances, toward foremen, operating personnel, technicians, and the like; other organizations may present special versions of technical material in a nontechnical manner for management executives, administrative personnel, sales and advertising people, to keep them informed about engineering progress. All are performing a specific function to fill a specific need.

So, while there may be an apparent similarity in subjects discussed, most would be explained by interest-level differentiation—interpretation for different levels of technology. Better selectivity by attendees may be the answer.

Then take, for example, an engineering society like ASME. The Society has a specific obligation to its members: Bringing to their attention, through meetings and publications, the latest mechanical-engineering developments.

In order to satisfy the technical interests of its members, ASME has recently abandoned its Spring and Fall National Meetings. At the same time the Society urged that all of its Professional Divisions—of which there are now 25—hold an annual conference. Result: During 1959, in addition to the Semi-Annual and Annual Meetings, 21 Divisions will be holding Conferences—some jointly with other societies (to cut down or eliminate duplication). Four divisions will also be participating or co-operating in meetings of other organizations.

Why this multiplicity of ASME Conferences? ASME is a horizontally organized Society and covers many disciplines within the general field of mechanical engineering. These conferences have been designed to fulfill the needs and interests of the specialists.

That the ASME swing to conferences has met with success is evidenced by the fact that in its first full year of operation attendance by members at meetings has more than doubled. Thus the Society is once again fulfilling its prime objective: Better service to members.

So the questions of whether too many meetings are being held and whether too many similar papers are being presented are still just questions.

Comments, anyone?—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.
Editor Emeritus, GEORGE A. STETSON

DEVELOPING from an ENGINEER to an ADMINISTRATOR

By Oliver J. Sizelove, Mem. ASME
Pofessor and Chairman, Department of Management Engineering, Newark College of Engineering, Newark, N. J.

To become an administrator, an engineer must (a) possess or acquire a knowledge of the principles and techniques, (b) have the necessary personal qualifications, (c) be able to apply the scientific method of thought to a variety of problems

MANY engineers by their nature achieve complete job satisfaction in strictly technical work and do not possess the essential personal qualifications necessary to the successful administrator. This is really fortunate—for in these days of increasing complexity of the technical nature of our products we need not only competent administrators with technical background but equally competent engineer-scientists to do the work of research, design, development, and manufacture.

Other engineers may develop into administrators through one of several situations. If they inherently possess the necessary personal characteristics, they may, with adequate training in both the principles of management and administration, become successful administrators. If they possess the latter and lack the former, their efforts to become administrators are doomed to failure—in fact, they should not even be permitted to try.

Too many young, excellent technical engineers have been trapped in this dilemma. Perhaps they are largely at fault for accepting promotions to project leader, group leader, foreman, or superintendent. The error in judgment is more likely that of their superiors, the administrators who labored under the false assumption that an excellent technical engineer is necessarily an excellent potential engineer-administrator. The relationship is more often inverse rather than direct.

A number of excellent technical engineers, on the other hand, find themselves in administrative work having had no formal training in the principles of management and administration, and yet do a reasonably creditable job. These men had a flair for managing and had sufficient intelligence to acquire a knowledge of management techniques informally, by observation, by self-study, or some combination of these methods. Equally important, their flair for managing stemmed from their inherent possession of the necessary personal qualifications.

There are other engineers who find after employment that they will never excel technically—perhaps because of lack of interest, and perhaps because the basic sciences were never thoroughly mastered in their formal training. Regardless of the reason, those who possess the necessary personal qualifications become successful administrators if they acquire a knowledge of the basic principles of administration and management. Actually, about the same percentage of excellent technical engineers and poor technical engineers become able administrators—when they possess the necessary personal qualifications.

In addition to these two common elements, (*a*) knowledge of basic principles and techniques, and (*b*) the necessary qualifications, there is apparently a third. The fact that they are all engineers indicates that they all have been subjected to the rigors and discipline of an engineering curriculum—more specifically, they have all been trained in the scientific method of approach. This is the third common element. The technical superiority of some is indicative largely of the mastery of individual engineering subjects. This is not necessarily an indication of greater ability to apply the scientific method of approach in solving varied types of problems. The ability to apply the scientific method of approach to problems other than those that are strictly technical, that is, to problems in management and administration, is equally important to the successful engineer-administrator. All elements must be present to become an administrator.

Basic Principles and Techniques

The era of "management by opportunism" became obsolete as a means of managing an enterprise with the successful introduction of Taylor's "scientific management." Yet, more than a half century later, some administrators are still using this outmoded means. They are almost nonexistent, however, in any highly competitive industry, because such managers have been eliminated by competition itself. To be and stay competitive in today's industry the manager must not only use the basic principles and techniques of management and administration, but he must keep abreast of the newer mathematical and statistical techniques.

Over the years, it has become evident that for the man whose goal upon graduation is some staff capacity in manufacturing, basic courses in management are extremely valuable and should be part of his undergraduate work. For the man whose goal upon graduation is research, design, or development, those basic courses are not as essential. However, there is sufficient evidence to indicate that the design engineer, for example, who has this knowledge is capable of more effective job performance. Hence the industrial engineer who usually begins his career in an industrial staff position has the necessary academic training. Other engineers who begin their careers similarly, may or may not have this basic aca-

Contributed by the Management Division and presented in a joint session with the Maintenance and Plant Engineering Division at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 58—A-240.

demic preparation. Those engineers who begin their careers in research, design, or development may or may not know about management and administration.

There is much to be said for reserving at least the specialized and advanced material for the graduate years. Both maturity and interest at this level make the subject matter more meaningful and usually lead to more ready mastery.

Personal Qualifications

There have been a number of published lists of personal qualifications for a successful administrator and they have much in common. Kroon[1] listed the following eleven qualifications intially prepared by Burleigh B. Gardner. Successful administrators must: (*a*) Accomplish and achieve in order to be happy; (*b*) submit to authority without resentment; (*c*) have strong drives toward material rewards and prestige; (*d*) possess the ability to bring order out of chaos; (*e*) be decisive; (*f*) know what they are and what they want; (*g*) feel that they have to keep moving, be active; (*h*) have a pervasive fear of failure; (*i*) concentrate on the practical, the immediate, the direct; (*j*) be able to identify themselves with their superiors, who constitute a symbol of the achievement and activity they desire for themselves; (*k*) feel and act as though each were a "man who had left home," that is, had severed emotional ties and obligations with parents.

This or any other similar listing could apply to success in nearly any profession, but there are several points which apply most to the engineer-administrator. Points (*c*), (*d*), (*e*), (*g*), and (*i*) would, in the author's opinion, distinguish the engineer with administrative potential from those with greatest potential in purely technical work. Further examination reveals a fortunate circumstance—these qualifications are of such a nature that their presence or absence can be directly evaluated by departmental faculty while the man is still in engineering school, as well as by the engineer's superiors after a relatively short tenure of employment.

Scientific Method of Approach

There is little need to dwell upon what is meant by the scientific method of approach. Davis[2] gives eight points: (*a*) Recognition of the problem and the general determination of the principal difficulties that are involved; (*b*) preliminary observation and analysis, including determination of the limiting factors in the problem; (*c*) the development of tentative solutions; (*d*) the testing of proposed solutions; (*e*) the development of the best practicable solution; (*f*) the final testing of the solution; (*g*) intelligent compromise; (*h*) installation and activation of the agreed plan.

In the final analysis this is what was really learned in four years of engineering school. The subjects in the engineering curriculum were the basic tools which permitted engineering problems to be solved by the scientific method. The better the mastery of the tool subjects, the better the ultimate solution of the engineering problem. Once the scientific method of approach has been mastered, it can also be effectively applied to other than technical problems. In the case of the engineer-administrator, these tools are the principles of management.

[1] R. P. Kroon, "The Engineer Looks at Management Positions," MECHANICAL ENGINEERING, May, 1956, pp. 427–429 and 453.

[2] Ralph C. Davis, "Industrial Organization and Management," Harper & Brothers, New York, N. Y., 1957.

It is important to recognize that the engineer has no corner on the scientific method. It is the method of thought used by all professionals. It is equally as important to the administrator as it is to the technical engineer. This, of course, is why successful administrators have come from the professions of law, accounting, and so on, as well as engineering. In view of the increasingly technical complexity of manufacture, however, it would seem that in the years ahead the engineer's technical background should give him a decided edge over men from other professions in becoming a successful administrator.

Transition From Engineer to Administrator

In order for the transition to an administrative position to be successful, the engineering candidate should (*a*) either possess or be in a position to readily acquire a knowledge of the principles and techniques of management and administration; (*b*) have measured up to the personal qualifications; (*c*) have demonstrated mastery in applying the scientific method of approach.

Any system for effecting this transition should locate the potential engineer-administrator as early as possible, and then follow his on-the-job performance closely until it is certain that he satisfies these conditions. This would apply whether he is employed in research, design, development, or as a staff man in manufacturing.

At the first stage of evaluation and upon his graduation from engineering school, his professors and department head and the industrial recruiter are probably in the best position to make a sound judgment of the engineer's potential as an administrator.

Engineers showing administrative potential may, upon graduation, be placed in appropriate training programs, in staff positions, or in research, design, or development. The nature of the initial job is not too important provided that it is engineering and the potential engineer-administrator can be followed closely with periodic evaluation of his performance. This is so because experience is another obvious and previously unmentioned ingredient for final evaluation of an engineer's potential as an administrator.

For this evaluation a rating form could be designed and could be periodically completed by the man's superiors. Thus his progress at, say 3, 6, 9, and 12 months after employment could be recorded and evaluated in terms of possible success as an engineer-administrator. It would appear reasonable that a reliable decision on the man's potential could be made in most instances after a year.

All potential engineer-administrators are not hired directly from college, but engineers hired after previous employment, or presently employed by a company and believed to have administrative potential, could still be evaluated by this procedure. Many engineers with administrative potential are overlooked because someone has voiced the opinion that they would never make managers. Opinions that are not well-founded or are based on prejudice or misinformation would be minimized by this type of procedure.

Here then is a procedure, the details of which will vary for each company, which will locate, follow, and ultimately select engineers with administrative potential. The selection will be based upon satisfactorily measuring up to the necessary personal qualifications, possessing a knowledge of the principles and techniques of management and administration, and ability to use the scientific method of approach. ●

"Mission

THE "mission concept" in air transportation implies that all phases of service must be specifically designed for the requirements of a particular system. The Lockheed Electra was conceived to give profitable operation on missions in the high density section of the airline pattern known as the "short to medium" range, with operational flexibility enabling it to serve also the lower traffic requirements on flights up to 3400 statute miles.

Maintainability

Lockheed engineering management decided several years ago to intensify its efforts toward improving aircraft maintainability through design. In order to do this effectively, the existing Maintenance Design Staff group was expanded by adding a number of highly qualified airline engineers whose function is to look over the design engineer's shoulder and determine whether the design is acceptable from the standpoint of practical field use and operation of the airplane. Two of the original ten engineers in the preliminary design team for the Electra were from this group.

This phase of design effort led to the development of service centers, which house the hydraulic, electrical, and air-conditioning systems. All of these areas are reached through doors in the bottom of the fuselage.

Rapid ramp servicing was another objective. All such operations, with the exception of galley service, are conducted on the right side of the Electra, leaving the left side uncluttered for passenger exit and entrance. Demonstrations have proved that the enroute-servicing target time of 12 min can be easily met, and that terminal turnaround can be accomplished in 20 to 30 min. Operational features which have helped to make this possible include self-contained starting, heating, and cooling provisions, integral loading steps, single-point pressure refueling, and high allowable landing weight, which permits a series of flights without adding fuel.

How Tough Is the Structure?

The good intentions of aircraft designers do not always produce an acceptable article from the airline operator's point of view. In order to insure that the Electra would fulfill the operator's requirements, Lockheed has conducted the most comprehensive test program in its history of commercial airplane production.

The Electra structure has been designed for unlimited fatigue life and to "fail-safe" in case of damage. The fail-safe properties of the wing were demonstrated by a series of tests conducted on a representative wing box, which was loaded in bending, shear, and torsion to reproduce design conditions as required by CAA. Saw cuts were made in the wing surface and the shear web while under load. After complete failure of the element being cut, the load was increased to the design limit. This load was held without failure or distortion, demonstrating strength well in excess of CAA requirements.

The objectives of fatigue testing were to eliminate points of weakness and to insure that all portions of the structure were operating at stress levels well below the full capabilities of the material. As a result of extensive tests of wing joints and surface discontinuities, modifications were made in the outer-wing-panel to center-section joint and in material distribution and detail radii.

Similar fatigue tests were carried out on the fuselage structure. Cyclic pressurization loading and simulated propeller-forced vibration were used to study fatigue characteristics of the structure. Development of forged window frames and increased fuselage stiffness in the propeller-plane area resulted from these tests.

A structurally complete Electra fuselage was used to demonstrate its fail-safe characteristics. Various combinations of skin and structural members were precut, after which the fuselage was pressurized and loaded to simulate flight conditions. Spears, varying in width from 6 in. to 24 in., were then shot through other skin areas, rings, and stringers to give a combination of static and dynamic damage. A total of 19 static and 19 dynamic cuts were made in a series of eight tests.

During the final test, when the spears pierced the skin, a 1 × 6-ft panel blew out, carrying with it additional skin, 100 feet from the fuselage. The 55-lb gun assembly used to fire the spears traveled 48 feet, and parts of the gun cradle 140 feet. Despite the violence of this explosion and damage to the fuselage, the structure continued to carry the load, without failure or additional damage. Under all loading conditions and damage inflicted the fuselage proved completely fail-safe.

Many other structural tests were, of course, conducted during the development of the Electra, including those of the windshield, windows, empennage, and nacelles [1].[1]

Based on a paper contributed by the Aviation Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Numbers in brackets designate References at end of paper.

Concept" – the ELECTRA philosophy

By C. F. Schmidt, Operations Engineering Specialist, Lockheed Aircraft Corporation

The Lockheed Electra incorporates features and characteristics designed to meet specific airline service requirements. This is "operations engineering," the new emphasis in airliner design.

Lab Tests of Operating Systems

Over 220,000 simulated landings were made with the Electra landing gear in the Lockheed-designed test rig. In addition to operational and structural checks, drop tests were made to determine impact absorption characteristics. Shimmy tests of the nose landing-gear mechanism revealed excessive friction in the system, and this was removed by redesign.

The elevator control system was reproduced in a mock-up, which was subjected to a CAA-witnessed 50,000-mission endurance test. One slight indication of wear was detected during this program, and design changes were made in order to improve service life.

The wing-flap mechanism was also set up in the laboratory in order to establish the optimum configurations of control valve, follow-up mechanism, and actuators. 7000 full-load cycles were applied to the system, without evidence of excessive wear or changes in operational characteristics.

An extensive laboratory development program was conducted on the Electra air-conditioning system. Preliminary mock-ups were used (*a*) to determine basic air outlet configurations for flight station, cabin, and lounge; (*b*) for comfort studies, i.e., temperature stratification and draft surveys; and (*c*) to assess performance of cabin heating systems. A final air-conditioning mock-up was then constructed, and tests were conducted to develop temperature-control-system compatibility, the Freon cooling system, and solutions to detailed equipment problems such as air-outlet noise.

One of the unique features of the Electra design for cabin comfort is the use of radiant-heated floor and wall panels. One of these was operated for 120,000 power cycles over a period of five months while being subjected to heavy foot traffic. No failures occurred.

Flight Development of Engines

As the Electra goes into airline service, its power plant has accumulated nearly 400,000 hr of operation in test and simulated airline conditions.

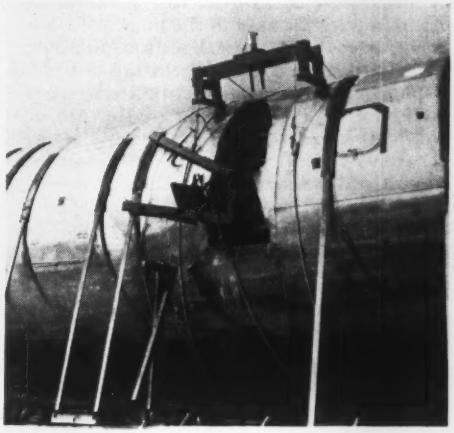
Ten months before the scheduled first flight of the Electra airplane, Lockheed's flying-test-bed Constellation (1961S) took to the air with an Electra engine nacelle installed in the No. 4 position. During 16 months and 167 flight hours, this engine was tested for performance characteristics, cooling, icing, starting-system operation, and installation effects. In addition, propeller-operation tests and vibratory-stress surveys, cabin-supercharger investigations, and inlet-duct-pressure surveys were conducted.

This program resulted in engine and installation refinements which were incorporated before flight in the production airplanes. Among these were the anti-swirl vanes, installed aft of the engine nozzle-exit plane, and tailpipe-area modifications. These changes provided improvement in Zone I cooling and a gain in eshp,[2] produced by increased pumping effectiveness of the augmenter, which is part of the installation design.

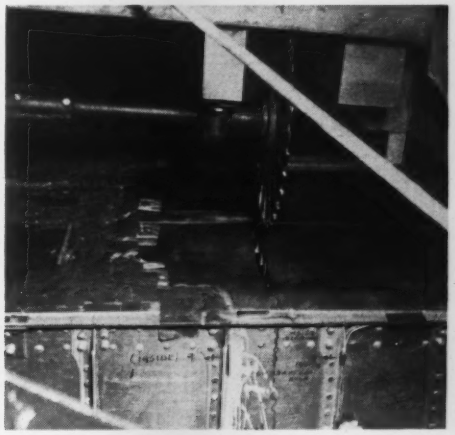
Programs were conducted concurrently by Allison on their Indianapolis test stand and on a Convair airplane in which D-13 engines and Aeroproducts propellers

[2] Equivalent shaft hp, which includes the effect of jet thrust. For these Allison D-13 engines, eshp is 3750.

After 19 precuts and 19 dynamic cuts, this panel blew out of the pressurized fuselage, a violent explosion. The structure still carried its load.



After cuts made through shear web and surface, the wing sustained its full design load, without distortion, demonstrating "fail-safe" construction



had been installed. The latter program, known as "Operation Hourglass," accumulated 1000 hr of simulated airline flight [2].

Lockheed C-130A Hercules aircraft have been in operation by several squadrons of the USAF. These airplanes, using essentially the Electric power package—the Aeroproducts propeller and the Allison T-56 engine (basically identical to its commercial counterpart, the D-13)—have amassed a formidable background of experience on missions which closely approximate airline operation. On these missions, and in special Air Force tests, the power plant has been subjected to extreme variations in climatic conditions.

The Electra Takes Off

The Electra was first airborne on Dec. 6, 1957, 55 days ahead of schedule, inaugurating an intensive program to evaluate performance, systems operation, structural loads, stability, control, and operational characteristics. Various phases of the testing were distributed among four aircraft assigned to the program.

Electra No. 1 was earmarked for investigation of basic performance, stability, flight characteristics, powerplant installation effects, propeller vibratory stresses, and accessory operation, followed by the major portion of the CAA certification program. The second airplane was used primarily for study of operation of the basic aircraft systems, as well as the autopilot, various automatic "couplers," fire detection and extinguishing, generator cooling, and so on. An extensive series of flights in icing conditions was also conducted on this airplane in sections of the U. S., including Alaska.

Sound and vibration surveys were conducted on the third Electra, serial 1004. The air-conditioning system and radio operation on the ground and in flight were also evaluated. The most important use of this airplane was to test functions and reliability of the entire aircraft and its components, a program which culminated in the demonstrations to the CAA prior to certification.

Serial 1005, the fourth aircraft in the program, was used to test and develop radio installations and for performance demonstrations.

Virtually all data were recorded automatically. On the No. 1 airplane, three synchronized Automax cameras photographed instruments indicating all basic parameters for engine and aerodynamic performance; two oscillographs recorded strain-gage measurements of structural loads experienced during flight; and a continuous survey of more than 100 temperatures was maintained by an automatic recorder.

Also on Electra No. 1, the pilot's control wheel and rudder pedals were replaced with special units equipped with strain-gage instrumentation for measuring pilot effort about all axes. A wing-tip boom swivel airspeed probe system was used as a cross reference against the Electra's standard systems and to measure angle of attack and yaw.

The first airplane's cabin was equipped with a specially designed water ballast system, consisting of 19 tanks, among which water could be transferred to vary center-of-gravity location for stability and control studies. This was a refinement of the system used in early test programs on the Constellation.

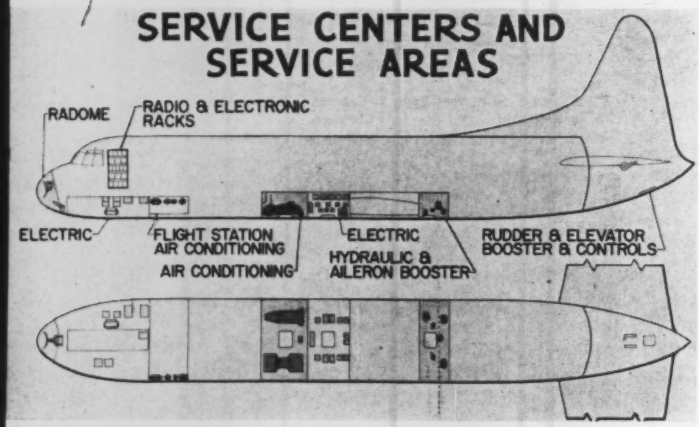
For evaluation of take-off and landing performance, the Lockheed-developed "TOL" motion-picture camera was used. This device, mounted in the belly of the airplane, by means of a mirror arrangement photographs on each frame of film, reference points on each side of the runway, a timer light, and a counter for synchronization with automatic observer data. Distance, time, and height information are obtained with a high degree of accuracy from this equipment, and it has been accepted by the CAA as a standard method for measurement of take-off and landing performance.

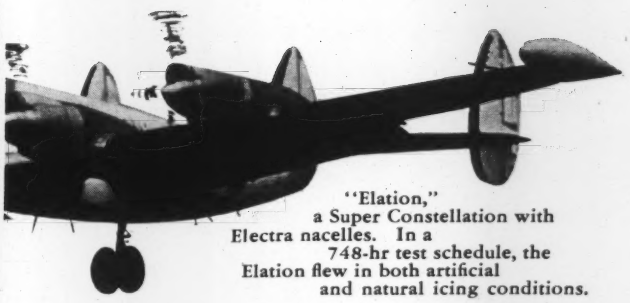
The Proof Is in the Flying

First tests indicated the desirability of certain design changes. For example, the rudder area was increased in order to provide lower minimum-control speed and thus improve the performance where this factor is critical. The elevator force-link (stabilizing) tab configuration was altered to improve stability in extreme maneuver conditions required for CAA demonstration. The control-boost ratios on all three surfaces were revised, resulting in excellent pilot feel. Emergency-brake lines were filled with oil to eliminate the lag experienced with air only in the lines.

During one of the critical tests of minimum landing distance with three engines operating, a combination of atmospheric conditions, low approach speed, and accidental momentary operation of the propeller in the ground-idle range resulted in a very severe landing. Fortunately, this airplane was fully instrumented for structural-load measurement. The actual rate of descent at impact was 18 fps, compared to a design limit of 10 fps. This impact exceeded the typical design-limit sinking speed for carrier-based fighters.

Service centers, reached through the bottom of the fuselage, house hydraulic, electrical, and air-conditioning systems





"Elation," a Super Constellation with Electra nacelles. In a 748-hr test schedule, the Elation flew in both artificial and natural icing conditions.

Detailed inspection revealed minor damage to the upper surface of the right-hand wing and rib attachment tabs. Nacelle and engine-attachment bolt torque was unaffected, and there were no fuel leaks. No other damage could be found.

Since a contributing factor to this incident was momentary operation of the power levers in the Beta (ground) range prior to touchdown, an intensive study of this system was made, leading to design modifications. The power levers now incorporate a restriction which prevents inadvertent movement into the ground position until at least one main landing gear is bearing sufficient weight to close the scissor switch. A 10-lb pull is required to override this restriction.

Specialists in airline-operations engineering participated in all parts of the flight program, studying the airplane and its characteristics from the viewpoint of airline-operations personnel. Using this realistic information, members of this department prepared the aircraft-operations manual as well as cruise-control presentations for airline use.

CAA Type Certificate

Awarding of the CAA type certificate for the Electra took place on Aug. 22, 1958. During the test period, the four test airplanes made 655 flights, on which were accumulated 50,700 ft of automatic observer film and 27,250 ft of oscillograph records, from which 725,000 data points were extracted. Although the maximum weight for which certification was sought was 113,000 lb, actual tests were conducted at weights above 116,000 lb, thus providing data on which future increases can be based.

As a result of the thorough precertification program of flight testing conducted on the Electra, during which the final airplane configuration was evolved, the actual official CAA-witnessed demonstrations were more or less routine. It may be of interest that, despite the severity of landing and rejected-take-off distance tests, no tire blowouts were experienced. (250 per cent spares are customarily allowed.)

Although an intensive search for cross-wind conditions at airports throughout western United States was made, the maximum value which could be obtained for demonstration was 20 knots, at The Dalles, Oregon. The airplane easily passed this test making four take-offs and landings, at weights in excess of the maximum landing weight, on a 4400-ft runway. Efforts are continuing to find more severe conditions so that the Electra's full capabilities can be utilized.

One of the most interesting portions of the certification program was that concerned with functional and reliability testing, sometimes referred to as "Accelerated Service Tests." The objective of this program was to fly the airplane as it will be operated in airline service, at a high utilization rate.

Three flight crews were assigned to the airplane during this period, and an average daily utilization of 17 hr was achieved. Maximum flight time in any one day was 18.49 hr. Total time accumulated in this phase of the certification testing was 165.6 hr.

Some refinements in operating technique were made as a result of this experience, and a few minor design defects were corrected. For example, several propeller oil leaks were experienced of a type not encountered previously in the flight-test program nor in similar Aeroproducts designs in service for several years. Investigation revealed that, in production of the oil-transfer tube housing, a recently modified tool was leaving a very small curl of metal at the base of the broached hole into which an O-ring fits. This was cutting the O-ring, causing it to fail. Polishing out the transfer tube housing eliminated the trouble.

Control and maneuverability under all normal and emergency conditions were found to be outstanding. In one demonstration to the CAA, simultaneous failure of an engine and its NTS (Negative Torque Signal) system was simulated, producing exceptionally high asymmetric thrust. At speeds from 140 to 160 knots (highest speed obtainable without operation of the decoupling mechanism), satisfactory control was demonstrated.

Mission Accomplished

As the Electra enters scheduled airline service, the design criteria have been met. It can fly to cities where 95 per cent of the world's air traffic originates (including over 300 U. S. airports), and over routes as long as 3400 miles, offering a high degree of riding comfort, safety, and schedule reliability, with loads of 66 to 99 passengers.

References

1 E. H. Spaulding, "Trends in Modern Aircraft Structural Design," presented at SAE National Aeronautic Meeting, New York, N. Y., April, 1957.

2 "Operation Hourglass," Allison Division of General Motors Corporation, 1958.

Ramp service. All operations, except galley service, are on the right side, leaving the left uncluttered for passengers.

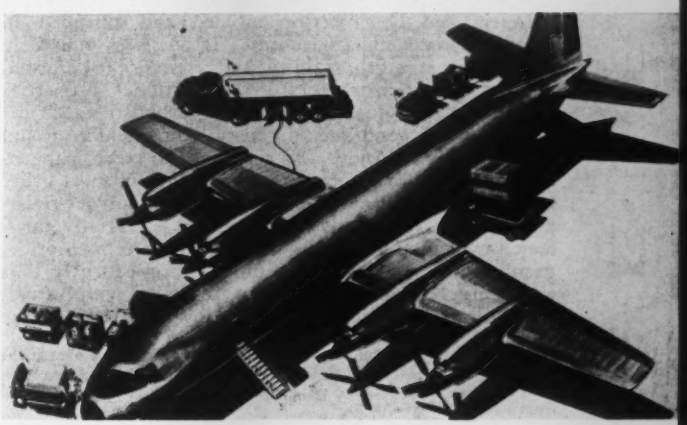


Table 1 Typical Properties of Delrin

Property	ASTM no.	Average values[a] for Delrin 500X	150X
Elongation at −68 F, per cent	D638	13	
at 73 F, per cent	D638	15	
at 158 F, per cent	D638	330	460
Izod impact strength at −40 F, ft-lb per in.	D256	1.2	1.8
at 73 F, ft-lb per in.	D256	1.4	2.3
Tensile strength and yield point at −68 F, psi	D638	14,700	
at 73 F, psi	D638	10,000	
at 158 F, psi	D638	7500	
Flexural modulus at 73 F, psi	D790	410,000	
at 170 F, psi	D790	190,000	
at 250 F, psi	D790	90,000	
Flexural strength, psi	D790	14,100	
Fatigue endurance limit at 73 F, 100 per cent relative humidity, psi		5000	
Shear strength, psi	D732	9510	
Heat distortion temperature at 264 psi, deg F	D648	212	
at 66 psi, deg F	D648	338	
Deformation under load of 2000 psi at 122 F, per cent	D621	0.5	
Compressive stress at 1 per cent deformation, psi	D695	5200	
Water absorption, 24-hr immersion, per cent	D570	0.12	
50 per cent relative humidity (equilibrium), per cent	D570	0.2	
Specific gravity	D792	1.425	
Rockwell hardness	D785	M94, R120	
Flammability, in. per min.	D635	1.1	
Melting point (crystalline), deg F		347	
Flow temperature, deg F	D569	363	
Coefficient of linear thermal expansion per deg F	D696	4.5×10^{-5}	
Thermal conductivity, Btu per hr per sq ft per deg F per in.		1.6	
Specific heat, Btu per lb per deg F		0.35	

[a] These values are representative of those obtained under standard ASTM conditions and should not be used to design parts which function under different conditions or as minimums in material specifications.

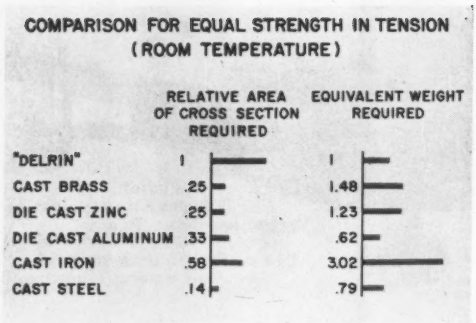


Fig. 1 Comparison for equal strength in tension at room temperature

"Delrin" *acetal resin is not a blend or copolymer of existing materials, but an important new thermoplastic engineering material with a combination of properties not found in any other single material. Delrin has outstanding tensile strength, rigidity, fatigue life, and resistance to creep and solvents at both room*

DESIGNING

By Watson C. Warriner, Plastic Sales Division, Polychemicals Dept.,

"Delrin" acetal resin, a superpolyoxymethylene and a new thermoplastic engineering material, offers an unusual combination of superior properties that will further broaden and extend plastic applications into fields now dominated by metals, Table 1.

Delrin can be injection molded and extruded in standard processing equipment. It possesses unusually high tensile strength, rigidity, and resistance to deformation at elevated temperatures. Frictional properties are excellent, approaching the fluorocarbons. Electrical properties are good and in general equivalent to nylon and polyvinylchloride. Its resistance to creep, particularly above 150 F, is far superior to that of most other thermoplastics. Delrin is one of the most solvent-resistant organic compounds known and is essentially unaffected by common solvents such as carbon tetrachloride, gasoline, oil, and hydraulic fluids. Consequently it is extremely resistant to staining at room temperature. Dimensional stability, because of low moisture absorption, makes it suitable for many mechanical components.

Delrin offers economies in the replacement of metals such as some types of zinc and aluminum die castings, brass castings and screw-machine parts, some sintered-metal parts, stainless-steel, and some carbon-steel applications involving high machining costs.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1958, of The American Society of Mechanical Engineers. Condensed from Paper No. 58—A-259.

An Engineering Material

Two series of resins will be marketed—a 500 series of molding resins, and a 100 series for extrusion purposes. A relative comparison of strength in tension and stiffness between Delrin and some widely used metals is shown in Figs. 1 and 2. Delrin is lighter than any of the die-casting alloys, having a specific gravity of 1.42, compared with 1.81 for magnesium die-casting alloy, 2.65 for aluminum die-casting alloy, 6.6 for zinc die-casting alloy, and 8.5 for brass casting alloy.

When these comparisons are considered on a joint basis of weight, stiffness, and strength, Delrin, unlike most other thermoplastics, is in a position to challenge these metals for many applications.

Pump impellers of brass or bronze and other similar

COMPARISON FOR EQUAL STIFFNESS IN FLEXURE (ROOM TEMPERATURE)

CANTILEVER RECTANGULAR BEAM ($Y = \frac{FL^3}{3EI}$)

	RELATIVE AREA OF CROSS SECTION REQUIRED*	EQUIVALENT WEIGHT REQUIRED
"DELRIN"	1	1
CAST BRASS	.32	1.91
DIE CAST ZINC	.32	1.66
DIE CAST ALUMINUM	.35	.65
CAST IRON	.33	1.75
CAST STEEL	.25	1.4

*WIDTH OF BEAM HELD CONSTANT AND THE DEPTH VARIED.

Fig. 2 Comparison for equal stiffness in flexure at room temperature for a cantilever rectangular beam

and elevated temperatures. These desirable properties are found in combination with dimensional stability and good electrical and frictional properties. Molded Delrin offers economies in replacing some types of aluminum and zinc die castings. Cast and screw-machine parts of brass are other lucrative areas.

with "DELRIN"

Fig. 3 Two-piece molded impeller for a multistage, deep-well pump

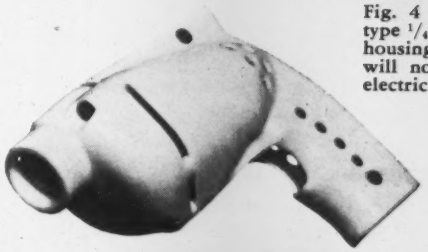


Fig. 4 Prototype 1/4-in. drill housing of Delrin will not conduct electricity

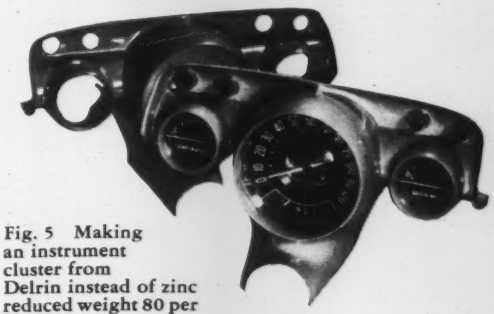


Fig. 5 Making an instrument cluster from Delrin instead of zinc reduced weight 80 per cent, cutting shipping cost and improving the handling during assembly

E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware

parts where high strength and stiffness are required in the presence of water offer excellent opportunities for Delrin. A two-piece molded impeller for a multistage, deep-well pump, Fig. 3, is a good illustration. Prongs and mating holes are provided to quickly, economically, and permanently join the two halves by applying a heating tool—an adaptable, more economical, and safer method than solvent welding used for most other thermoplastics.

A prototype 1/4-in. drill housing of Delrin, Fig. 4, was molded in an aluminum die-casting mold. Slight modifications to the housing permitted standard internal components to be installed for extensive field testing to determine future design requirements. This housing, almost twice as light as aluminum, will not conduct electricity and affords shock protection from both internal short circuits and accidental drilling into live wires.

The use of Delrin to replace zinc and aluminum in the die-casting fields as well as for screw-machine and cast-brass parts is potentially lucrative. Combining several different functional metal components into one molding offers additional savings, Fig. 5, and the price history of new plastics has been downward while metals, in general, have shown an increasing trend over the long term.

Where it is desirable to replace other plastics, parts for prototype evaluation can be produced with molds designed for other thermoplastics, although differences in shrinkage and other molding characteristics render them unsuitable for production purposes. Prototypes obtained by compression or transfer molding are usually inferior and not representative of good injection moldings of Delrin. For parts that are relatively simple in design, a new sample cavity designed for Delrin can often be prepared for less cost than converting the compression or transfer mold.

Actual tests have checked performance predictions based on structural calculations using data on Delrin in strength-of-material formulas (beams, flat plates, cylinders, tubes, and so forth) that are commonly used for metals.

All property data cannot be used in this way, and certain physical data, such as impact strength and abrasion, cannot be translated directly to part design by substituting these data in mathematical formulas.

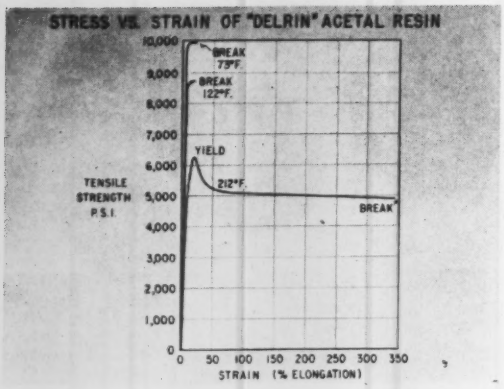


Fig. 6

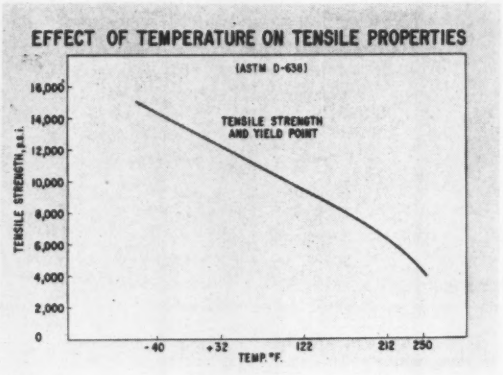


Fig. 7

Strength and Stiffness

Delrin is one of the strongest of all thermoplastics, Fig. 6. Its load-bearing qualities in both tension and compression are outstanding. The effect of temperature on yield strength, Fig. 7, is such that Delrin retains a high yield strength at 250 F. Tensile strength is affected no more than 10 per cent by moisture.

The high modulus of elasticity is retained both at elevated temperatures and when submerged continuously in water, Fig. 8.

Creep. Delrin has outstanding resistance to creep, particularly at 150 F and higher, Figs. 9 and 10. Owing to this property, it has excellent acceptance and permanent holding power for self-tapping screws and interference press fits. A steel shaft can be pressed into a Delrin gear or other part with good results. Plain shafts may be used, but knurled shafts give the best results.

Experimental data indicate that the creep rate levels off at stresses up to 5000 psi insuring a high retention of strength in a press-fitted joint stressed below this limit. Initially, 400 lb were required to remove a $^1/_4$-in. rod, with an interference fit of 0.007 in. on the diameter, and 70 hr of heating (to accelerate creep at 200 F) were needed before the parts reached equilibrium stress level. When cooled to room temperature, 220 lb were still required to remove the rod.

Because of these properties, Delrin has been found to be technically sound and economically attractive for replacing metal plugs in some hydraulic lines and crankcases.

Fatigue and Impact. Delrin has an unusually high fatigue endurance, Fig. 11, making it an excellent candidate for gears, since gear teeth are subjected to repeated cyclical loads. Even at 150 F and 100 per cent relative humidity, it still retains a high fatigue-endurance limit. Tests indicate an infinite fatigue life at less than 3000 psi. The presence of water or oil has almost no effect on fatigue life, but serves as lubricants where friction is involved.

Delrin is a tough, resilent material much like spring steel, requiring great force to deform it, and recovering almost perfectly if not bent too far. The unnotched Izod impact value or Delrin is 20.5 ft-lb per in. with 1.4 to 1.7 ft-lb per in. for notched samples. The difference in the values emphasizes the great importance of eliminating all sharp corners by the use of radii and fillets to reduce stress concentration. Unlike most thermoplastics, its impact resistance is not greatly affected by low temperatures. Delrin has an impact resistance of 1.2 at −40 F, which is only slightly less than the 1.4 at room temperature.

Table 2 Coefficient of Friction of Delrin on Steel

Conditions	Coefficient of friction[a] Static	Dynamic
Dry at 73°F	0.1-0.3	0.1-0.3
Dry at 250°F	0.1-0.3	0.1-0.3
Lubricated with water at 73°F	0.2	0.2
Lubricated with oil at 73°F	0.1	0.05-0.1

[a] Measurements were made by the inclined-plane method.

Gears

Good fatigue, tensile, and impact properties, as well as good frictional and wear properties coupled with dimensional stability, make Delrin an outstanding candidate for gear applications, Fig. 12. These are varied in their requirements and many gear-tooth profiles prove satisfactory in service. A 20-deg full-depth tooth provides good wear geometry, and the well-known Lewis equation can be used to calculate the gear-face width.

Frictional and Bearing Properties

Smooth, with a hard glossy surface, Delrin has a very low coefficient of friction, Table 2. It also has the unusual property of having the same value for both the static and dynamic coefficients of friction, eliminating "slip-stick." Little change is noted in the coefficient of friction from 73 to 250 F and up to 2500-psi load.

It is often possible and economically desirable to make the molded object serve also as its own bearing surface. The table-top conveyer replacing stainless steel, Fig. 13, illustrates this two-in-one solution made possible by the antifriction and corrosion-resistant properties of Delrin (3 per cent acetic acid at 165 F).

Possible journal-bearing applications can be screened by the use of PV values—defined as the product of the load per sq in. of projected shaft area P, and the surface velocity of the shaft in fpm V. Delrin performs well where only initial or no lubrication can be tolerated up to 1600 PV, particularly for high unit loads at low speeds. Continuously lubricated bearings of Delrin can be operated at considerably higher PV values. Connecting-

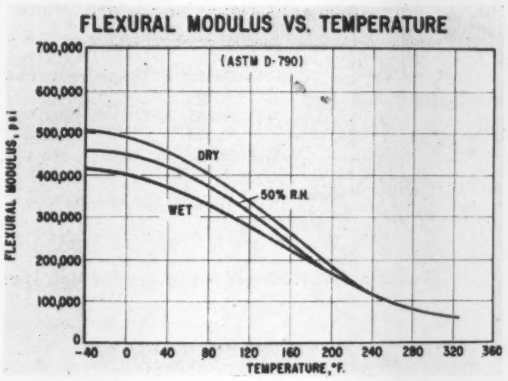


Fig. 8

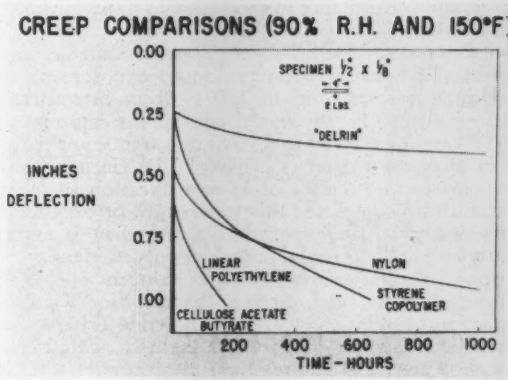


Fig. 9

rod bearings have operated at a *PV* of 10,000 at 170 F for 70 hr. However, Delrin to Delrin when operated dry is not a good bearing combination except where load and speeds are not a factor. The presence of an oil or water lubricant for this combination improves its bearing characteristics markedly.

While *PV* values are often indicative of the theoretical feasibility for journal bearings, bearings of Delrin should be prototype tested for performance confirmation.

Dimensional Stability

Dimensional changes in a plastic are caused by three major factors: (*a*) Expansions or contractions resulting from temperature changes; (*b*) volumetric changes resulting from water or chemical absorption or loss; and (*c*) changes in shape resulting from the release of stresses frozen in during fabrication.

Delrin has excellent dimensional stability. Its coefficient of linear thermal expansion of 5×10^{-5} in. per in. per deg F is roughly equivalent to most other thermoplastics and approximately five times that of carbon steel.

The equilibrium water content under normal atmospheric conditions—77 F, 50 per relative humidity—is about 0.2 per cent, and for total immersion in water at room temperature about 0.9 per cent. The rate of water absorption is governed not only by temperature and moisture environment, but by thickness of the part, thicker pieces requiring longer to reach equilibrium.

Dimensional changes in a stress-free part when transferred from one temperature-moisture environment to another may be estimated to within ±5 per cent. No allowance is needed for dimensional changes from release of stresses as long as parts are for use below 120 F. For higher service temperatures, annealing may be necessary after fabrication.

Delrin can be molded to ±3 mils per in. for the first inch and ±2 mils per in. for each additional inch of dimension. At greater costs, parts can be precision molded to ±2 mils per in. for the first inch and ±1 mil per in. for each additional inch of dimension. Since close-tolerance moldings are more expensive, prototype work should include the accurate determination of the tolerances actually required.

Allowances for mold shrinkage are made by the molder and toolmaker, and need not appear on drawings. Delrin's average mold shrinkage of 20 mils per in. can vary from 15 to 25 mils per in. depending on the geometry of the part.

Abrasion Resistance

Delrin's abrasion resistance is superior in general to most other thermoplastics. It is as difficult with plastics as it is with metals to relate laboratory abrasion-resistance data to specific design solutions. Prototype testing is the best means. However, for general orientation, a number of laboratory and practical tests have been run, and data are available.

Chemical, Heat, and Hydrolytic Resistance

Chemical Resistance There are no common organic solvents for Delrin at room temperatures, therefore it has excellent stain resistance to oils and greases. Data on resistance to some organic chemicals are given in Table 3. Delrin is not recommended in contact with strong acids.

Table 3 Resistance to Organic Chemicals

	Per cent change in 12 months					
	Tensile strength		Weight		Length	
Reagent	Room temp	158 F	Room temp	158 F	Room temp	158 F
50 per cent Igepal	+2	−58	−1.8	+0.1	+0.05	−1.21
"Nujol"	+1	+2	+0.3	−0.5	−0.08	−0.37
"Uniflo" motor oil 10W30	...	+3	...	−0.2	...	−0.30
Carbon tetrachloride	−3	−7[a]	+1.2	+5.7[a]	+0.30	−0.25
100 per cent ethyl alcohol	−5	−5[a]	+2.2	+1.9[a]	+0.81	+1.00[a]
Acetone	−5	−7[a]	+4.9	+2.6[a]	+0.91	+1.08[a]
5 per cent acetic acid	0	−8[a]	+0.8	−2.6[a]	+0.15	−0.22[a]
Toluene	−7	−7[a]	+2.6	+2.8[a]	+1.20	+1.20[a]
"Super 9" brake fluid	...	−6	...	+1.6	....	+0.57
"Lockheed" 21 brake fluid	...	−23	...	+0.9	...	+0.29
Ethyl acetate	−7	−7[a]	+2.7	+2.9[a]	+1.35	+1.10[a]

[a] Because of difficulties in carrying out the test these samples were tested at 122F instead of the higher temperature.

Test conditions:

1 Bars were completely immersed in solvent for time indicated.

2 Tests were made by standard ASTM procedures at room temperature immediately after removal of bars from solvents.

or bases, and performance in weaker acids or bases should be field tested.

Heat Resistance. Delrin shows no significant decrease in physical properties upon prolonged exposure to air in continuous service up to 180 F or in intermittent service up to 250 F. In water, continuous exposure up to 150 F can be expected to result in no significant reduction in physical properties. Parts of Delrin have been autoclaved for 100 cycles of 15-min duration in 250 F steam with no significant loss in strength or toughness.

Permeability. The permeability of Delrin is exceptionally low and a fraction of that of polyethylene when exposed to aliphatic, aromatic, and halogenated hydrocarbons, alcohols, and esters. Permeability data for some organic liquids and water are shown in Table 4.

Electrical Properties. Delrin is a material which combines good electrical and mechanical properties. It has a low dissipation factor and dielectric constant over a wide range of frequencies at both room and elevated temperatures. The volume resistivity is high and does not change appreciably from moisture absorption. Good electrical properties are maintained under high humidity or after complete immersion in water.

Delrin burns slowly at 1.1 in. per min (ASTM-D-635-56T), comparable to polyethylene, polystyrene, cellulose-acetate butyrate, and acrylics which are in common usage throughout the electrical industry.

Weatherability. Delrin, like most other polymers—acrylics and tetrafluoroethylenes are exceptions—is affected by ultraviolet light. For continuous exposure to sunshine, a black composition (507X) containing carbon black gives excellent results. Ultraviolet filters for improving weatherability look promising. Tests have shown that Delrin does not lose its properties when buried underground, nor is it attacked by fungi, rodents, or insects.

Table 4 Permeability to Organic Liquids and Water

Liquid	*P* factor[a] Delrin	*P* factor[a] Regular polyethylene
Methyl salicylate	0.27	9.1
Toluene	0.65	566.0
Turpentine	0.023	47.0
Ethanol	0.22	...
Water	3.0	0.35
"Perclene" (chlorinated hydrocarbon)	0.23	...
"Freon" 12/114	0.33	...

Test conditions:

Containers: Sealed 4-oz Boston Round bottles, blow molded, 35 mils thick.
Temperature: 73 F.
Humidity: 50 per cent relative humidity.

[a] *P* factor is defined as the grams lost per 24 hr per 100-sq-in. area per mil wall thickness. This factor permits the calculation of the loss that can be expected from any given bottle.

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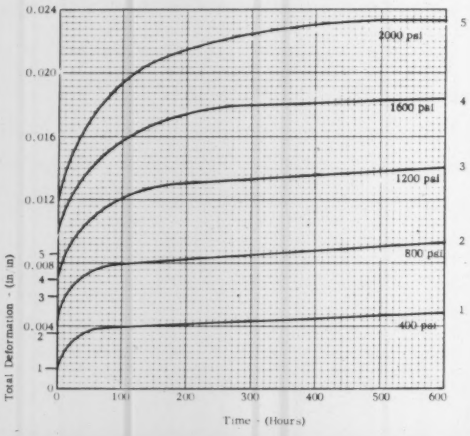


Fig. 10 Tensile creep data—total deformation of Delrin versus time under load at 160 F and 80 per cent relative humidity. The points indicated on the ordinate show the initial strain for curves 1 through 5.

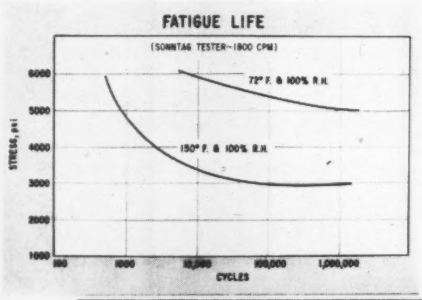


Fig. 11

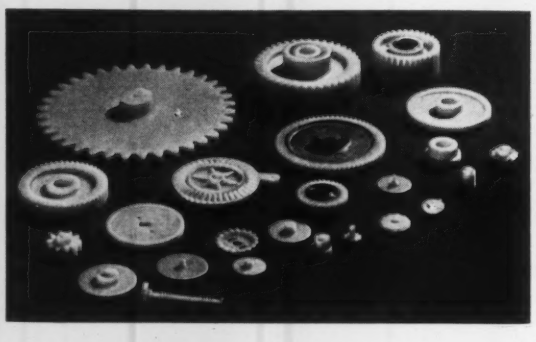


Fig. 12 Some of the many gear forms molded from Delrin and under test

Fig. 13 *Far right,* a molded object serves as its own bearing surface for a table-top conveyer

From that first interview, to the day when the once raw graduate has attained management stature: Here are the methods by which modern industry seeks and cultivates its high-potential manpower.

Finding and Developing TECHNICAL PERSONNEL[1]

By R. G. Alleman and W. E. Alexander

RECRUITING[2]

DURING the past eight years, du Pont has interviewed an average of 5478 BS and MS students per year. Our needs at the BS-MS level for technical people during this same eight-year period have averaged 874 per year.

Since our company believes in promotion from within and basic on-the-job training, and since we normally start candidates out at the "grass-roots" level, it is natural that colleges and universities should be our principal source of supply for technical manpower.

Recent figures prepared by the Engineering Manpower Commission of the Engineers Joint Council indicated that there will be approximately 37,000 individuals receiving their first engineering degrees in the 1958–1959 period. This, then, will be our major source of supply for next year's college recruiting.

Recruiter on the Trail

With rare exceptions, each man doing technical recruiting for du Pont is an engineer or chemist. Last year we had seven full-time recruiters doing BS-MS technical recruiting. Each representative interviewed perhaps a thousand individuals, and maintained contacts with over a hundred faculty members and placement officers at perhaps 30 different colleges and universities. Last year, we interviewed a total of 7510 BS-MS technical candidates at 188 colleges and universities.

Preparation for a college visit is normally handled by the placement representative assigned to this college and will include detailed instructions to the placement officer as well as letters to key faculty members. On occasion, letters are written to students who were summer employees or about whom we have information indicating their suitability as employees.

Most of our recruiting occurs on the college campus, and normal procedure has been for our placement representatives to talk privately and informally with the students on a scheduled 20-min basis. Interviewing facilities are usually provided by the university placement office. Our interviewing techniques are certainly not magical but do consist of a careful, thoughtful effort in evaluating each candidate to see how he might fit into the company.

Our placement representatives do not give candidates formal tests on campus and we usually don't request that

[1] Based on two papers contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, Denver, Colo., Sept. 21–24, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Condensed from "Recruiting the Engineer," by R. G. Alleman, Personnel Division, E. I. du Pont de Nemours & Company, Wilmington, Del. ASME Paper No. 58—Pet-11.

a candidate take a test prior to employment. Pertinent information about opportunities in our company, which may be suitable in view of the student's interest, is discussed. A real effort is made to match the candidate and an appropriate job opportunity.

After each interview, the candidate is rated for total suitability in the company and a portable dictaphone is used to dictate an interview report on the candidate. This report, together with an application for employment, is later made available to a specific plant, laboratory, or sales location that might be interested in the candidate.

Interview at the Plant

It is now up to the plant, laboratory, or sales location to decide whether or not they would like to invite this particular student in for a day of interviews at their expense.

Part of this decision is based on quantitative needs and their past experiences with other men from this college or university. They will lean heavily, of course, on the comments made by our interviewer and the information contained in the candidate's application for employment. Upon specific request, the student will be invited to visit for further discussions concerning employment possibilities.

If a student accepts our invitation we are on parade, and it is our job to evaluate him as a possible future employee and to make such employment seem attractive to him. The proper planning and handling of such plant, laboratory, or sales office visit is a special subject in itself. The visitor is our guest for a day and we must paint a favorable but factual picture of his visit with us. It is important that we not only select the candidate but that the candidate select us.

After a candidate has visited a du Pont location, we must promptly decide whether or not we want to make him an offer of employment. During his visit at our location, several responsible individuals have made a very real effort to see how he might fit into the company and into their location, and to appraise him not only for his ability to handle an initial job assignment but to his possible ultimate progress. Once again, there is nothing magical about this process; it is not something we do by means of tests, but it does consist of careful, thoughtful effort in evaluating the individual.

In many cases, this offer is made to him before he leaves our location and, at any rate, he is sent a written offer of employment or a letter stating that we do not plan to make him an offer.

The Firm Offer

The salary offered a candidate will depend on his level of academic training and, of course, credit will be given for usable work experience and for military service. It must compare favorably with the leading companies in American industry. In most cases, the plant, laboratory, or sales unit follows up this offer with other pertinent information about the company and maintains contact with him until he finally reaches his decision. We believe this is a critical period in the success of our recruiting program, and much time and effort are spent in giving the candidate additional information about our company and the specific employment offer.

During the period July 1, 1955 to June 30, 1956, a total of 7541 BS, MS, and PhD technical candidates were interviewed on various college campuses by our placement representatives. Of this number, 58 per cent were referred to our various locations for additional consideration. Of the original number interviewed, 50 per cent were invited in as our guests for interviews, and 37 per cent of those interviewed did visit with us at either a plant, laboratory, or sales office. Of the original group, 31 per cent were offered employment and 10 per cent of the original group did accept our employment offers. This means that we interviewed about 10 people for each one hired and this sifting is done both by the company and by the students. Perhaps these figures will have additional meaning to you if you realize that our company had 7387 male graduate engineers as of March, 1957.

During the 1956–1957 recruiting year, local and national companies provided keen competition for the technically trained men then available. For instance, at a well-known midwestern university there were 100 chemical engineers obtaining BS degrees; 50 of these were committed for graduate work or military service. Two hundred national companies then interviewed and tried to hire the remaining 50 engineers. At a well-known southern university, 195 local and national companies interviewed 206 graduating engineers. At certain engineering colleges, it was necessary to schedule interviews one year before the requested date. The total effect of all this developed some unfortunate recruiting and employment practices.

Recruiting Standards

Broad proposals to protect college students from high-pressure job-recruiting tactics have been published by the Chamber of Commerce of the United States and the College Placement Council under the title "Principles and Practices of College Recruiting." This publication offers a single set of recruiting standards for voluntary acceptance by all colleges and employers including governmental agencies.

The principal objective of the proposals is to promote "a wise and reasonable" choice of career by the student himself and "to strengthen in him a high standard of integrity and a concept of similar standards in the employing organization in the country." These recommendations are based on studies by business groups, federal agencies, college-placement officials, and officers of private and state universities brought together by the Chamber and Council.

If we are to keep technical graduates in greater supply, it is important for all of us to be sure that a technical career is made to appear as attractive as possible. It is important that qualified candidates be given assignments which really utilize their technical knowledge and that reasonable salary scales be maintained. All of us must be sure that engineering remains in a truly professional category, and that some of the more promising high-school students will want to become professional engineers. If we don't do this, these capable young people will enter other professions and, once again, we will have an acute shortage of engineers.

TECHNICAL PERSONNEL

EVALUATION and DEVELOPMENT[3]

THIS presentation will describe one approach to evaluation and development of industrial technical personnel, the program now employed by the Plastics Division of Monsanto Chemical Company. It represents an evolution over 20 years, through rapidly changing conditions and demands for almost continuous revision to keep pace with expanding needs.

Instrumentation

Our program makes use of the following tools:

1 Position guides.
2 Performance reviews (interview).
3 Job performance appraisal report.
4 Corrective and/or development program.
5 On-the-job coaching.
6 Key personnel ratings.
7 Replacement charts.

The base for our program is the development by the employee and his supervisor of a position guide, or job description, specific to his current position and his ability to perform. This document describes his function, major responsibilities, and organizational relationships.

The Position Guide

A position guide represents a systematic method of defining what is expected of an individual in his job and enables the supervisor to be reasonably precise in defining his performance expectations for the job. It should contain at least three parts: (*a*) Functions, (*b*) responsibilities, and (*c*) relationships. It should be complete for the position. It should list only major specific responsibilities—minor responsibilities and duties, or elaboration on the major ones should be covered by job descriptions, job instructions, or by procedure manuals. Responsibilities must be stated in concise terms with effective use of action verbs. Distinguish between setting policy, planning programs, and action of execution, depending on level of the position.

The guide should be prepared in collaboration with the individual involved. At least, the supervisor should obtain and be assured of full understanding of the position guide by the employee.

[3] Condensed from "Evaluation and Development of Technical Personnel," by W. E. Alexander, Assistant Director of Engineering, Plastics Division, Monsanto Chemical Company, Texas City, Texas. ASME Paper No. 58—Pet-8.

Performance Reviews

The core of our program is the annual performance review, or counseling interview.

It is, of course, no more effective than the individual supervisor who conducts and guides the interview. He should keep the discussion within the framework of current organization and organization planning. Job orientation and instruction can be clarified for new assignments. Duties and authority can be brought into sharp focus.

The performance appraisal must develop the positive and negative contributions of the individual to his own area of responsibility and to the functional organization group of which he is a part. It should result in a specific program of action with scheduled corrective actions for overcoming or improving weak areas of performance.

The interview may be conducted in several ways, depending upon the personal characteristics of the interviewee, particularly his receptiveness to constructive criticism of his performance. We prefer and more generally use an indirect approach combined with preinterview preparation by both participants, including a self-appraisal by the interviewee. This method requires the interviewee to first present his self-appraisal, the supervisor following with his opinion, preferably in a back-and-forth discussion of the specific responsibility performance.

The direct approach, in which the supervisor simply "lays the cards on the table," is generally used only in problem cases, perhaps bordering on or leading to termination or demotion action. This type should logically follow previous "indirect approach" reviews which have failed to produce recommended corrective actions.

The performance review should be directed toward establishing areas for strengthening performance. Causes for deficiencies should be sought before suggesting corrective actions. Sound exploration of causes will probably determine whether corrections are possible of accomplishment or call for measures beyond the capabilities of the employee. From this analysis and discussion, corrective action should be suggested and agreed to by the interviewee with reasonable timing specified. This provides a specific and definite plan of corrective or improvement action. It may or may not include organizational or function change.

EVALUATION and DEVELOPMENT

Performance Rating Report

A summary record of the interview should be prepared immediately following the interview. This record is used for subsequent reviews and reference, and must become a part of the employee's personnel file.

There should be a section used for listing strong factors of performance and factors which hinder performance. Examples are: character, mental qualifications, judgment, imagination, ambition, supervisory qualifications, and so on. These may be supplemented with more specific characteristics for each principal one.

For example, the factor of "imagination" might be supplemented by creativity, ingenuity, inventiveness, resourcefulness, and vividness. These words can then be used by the supervisor to best describe strengths and weaknesses. Each characteristic need not be judged as strong or weak—only those which are sufficiently strong to demonstrate areas under good control and those sufficiently weak to indicate problem areas that can effectively contribute to personnel development.

The plan for improving performance should be recorded in the summary report. This should include specifically what will be done, by whom, and a schedule of timing. Action should include development activities directed toward improvement in performance for bringing about maximum utilization of the employee's inherent capabilities.

Finally, a summary of recommended organizational action should be recorded. This should include salary and organization status changes, increase or decrease of responsibilities, job rotation, placement in another function, stated trial period, termination, and so on.

A summary statement from the interview regarding the employee's own idea of his future goals—both short range and longer range—should be recorded. This should include his preference for type or field of work, ambition, and his understanding of requirements for achieving his personal goals.

Open and completely frank and honest discussion of individual performance does take courage. However, any supervisor who expects to progress to administrative and management positions should develop the ability to communicate his evaluations of subordinates effectively and for the betterment of the organization as a whole. No technical man enjoys being told he isn't doing a good job, or that what he thinks is an adequate or even excellent performance is failing to meet established standards. Nevertheless, it must be done in justice to the individual and to the organization of which he is a contributing member.

Follow-up action by the supervisor is essential to the success of the performance-review program. The supervisor should remain alert to recommend participation in training courses available within or outside the organization which would contribute to the specific needs of the individual. Failure to respond to suggested actions would indicate another performance review in less than the once-a-year that is usually sufficient.

Replacement Charts

Another phase of our program is the preparation of a key-personnel rating and replacement chart annually.

Our program is directed at development of higher levels of supervision into managers and administrators leading to junior executive positions. It is also extended upward as a means of selecting and developing junior executives into top management, senior executive positions. However, this program can be effectively applied to any organizational unit or group of units regardless of the level in the corporate organization.

The foundation for this activity is the performance review. The Key-Personnel Rating very briefly records: (*a*) the performance rating of the employee in his present position; (*b*) principal strong points; (*c*) factors for improvement; (*d*) development activities during past year; (*e*) development plans for coming year; (*f*) when and by whom he had a performance review; (*g*) the individual's future career objectives; and (*h*) management's estimate of future potential. This includes positions for which he is a likely candidate, an estimate of his potential in the suggested position, and his state of readiness to assume the responsibilities of the suggested position.

Much of the information on the rating sheet is then transferred to a replacement chart to form a color-coded "picture" permitting visual interpretation of the "health" of the organization.

The replacement chart is in the form of a functional-organization chart. Each position shows the incumbent, his age, the position to which he might be promoted, his state of readiness for the promotion, and similar data on his potential replacement.

Effective use of colors can serve as a traffic signal—predominantly green shows traffic is moving, and so is the organization. Too much red indicates it's past time to stop and carefully diagnose the trouble areas for plotting a forward corrective course of action. Predominant yellow would indicate excessive mediocrity and would point toward examination of training programs or effective upgrading of the personnel. Ages should be surveyed to assure against serious gaps in age brackets which could result in deficiencies for replacements for several retirements within a short period of time.

Conclusion

Results of this program have been gratifying. A sound basis for financial and organizational advancement is established free of one-sided opinion, favoritism, and other similar practices. Square pegs in round holes are avoided, or corrected with reason rather than by trial and error. Organization plans for future needs can be developed on a continuing basis rather than waiting for the need and discovering the absence of qualified people.

We have found this approach to have a very high receptiveness. Most employees seem sincerely and earnestly in search of constructive criticism of their performance and personal characteristics which affect job performance. The most severe criticism we've had is of supervisors who haven't had the courage to be frank and honest in the performance review. They may have taken the easy way out by including only complimentary comments in the interview when the subordinate had been aware of performance deficiencies through his self-analysis. Bold and courageous actions by the supervisors, regardless of level, are essential to the successful practice of such a program. ●

Abrasives must grind the new, hard metals, like titanium and zirconium, and they must grind the old familiar ones more efficiently, at lower cost.

The wear of ABRASIVES in grinding

This study of bonded abrasives probes the chemical reactions between metal and abrasive, their effect on abrasive wear, their modification by grinding fluids.

By **G. J. Goepfert**[1] **and Josephine L. Williams,**[2] The Cincinnati Milling Machine Company, Cincinnati, Ohio

THE wear of an abrasive in the grinding process occurs by dulling of the abrasive points and by fracture of the abrasive particle. Dulling of the point can lead to fracture when grinding stresses are in excess of the particle strength, or can lead to rupture of the bond posts holding the abrasive grain. In the latter case, abrasive grains are lost from the bonded products.

Wear by these processes can be readily understood from the relationship of the physical properties of the abrasive and the work. However, numerous instances arise in which excessive abrasive wear occurs and the observed wear has little relationship to the physical properties of the abrasive and work.

One example is met in dry grinding of titanium with both the conventional aluminum-oxide and silicon-carbide abrasive materials. Wheels containing either of these abrasives rapidly lose their cutting rate shortly after the start of the grinding process. Examination of the wheel surface shows that a metallic titanium coating on each abrasive grain has dulled the abrasive. This coating cannot be separated from the abrasive particle.

The practical approach taken to overcome this condition is to use very soft wheel grades and slow speeds. This accomplishes removal of the dulled abrasive through the medium of rapid wheel wear. Wheel efficiency suffers correspondingly.

The explanation for the inefficiency of the abrasive in grinding titanium has to be sought elsewhere than the physical properties of the abrasive material such as hardness, strength, and refractoriness, since the strength and hardness of titanium metal are not sufficiently different from other metals which are ground efficiently by the same abrasive materials. The possibility of chemical reactions between the abrasive and the work has been mentioned in a general way [1, 2, 3].[3] Few actual experimental data, however, are given.

Extent of Chemical Reaction

The first approach taken in this program was to establish the extent to which various work materials would react with the abrasive under conditions related to the grinding process. Temperature conditions were approximated in these reaction studies by means of the Leitz High-Temperature Microscope Furnace (Fig. 1).

This furnace is capable of heat-treating to temperatures up to 1500 C. Furnacing can be carried out in air or in a selected atmosphere such as argon, helium, nitrogen, and the like. The reaction and adhesive tests reported in this

[1] Director, Chemistry and Abrasives Research.

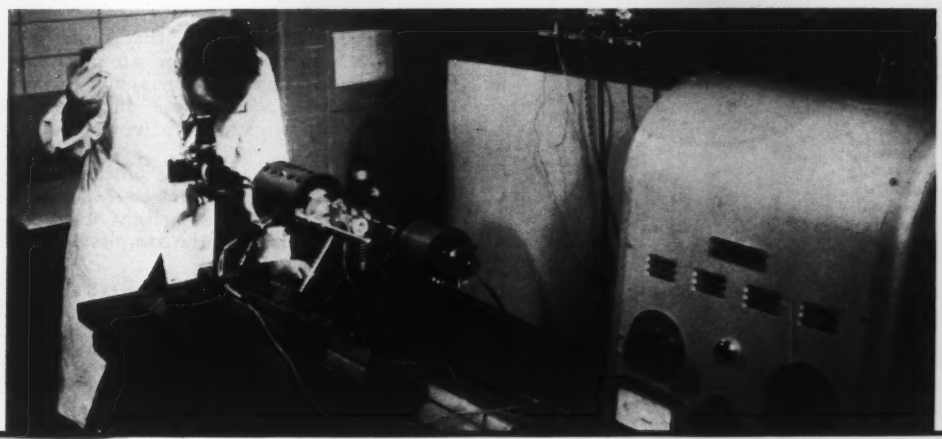
[2] Senior Research Supervisor, Chemistry and Abrasives Research Department.

Presented in part under the title of "The Physical and Chemical Nature of Abrasive Wear" at the Cincinnati Milling Machine Company's Technical Activities Seminar, Cincinnati, Ohio, Sept. 30–Oct. 10, 1957.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 30–Dec. 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 58—A-157.

[3] Numbers in brackets designate References at end of paper.

Fig. 1 Does chemical reation take place between the abrasive and the work? Here is the Leitz High-Temperature Microscope Furnace used in the authors' studies. The microscope has a camera attachment so that observations can be recorded on film. Most tests were run in an argon atmosphere.



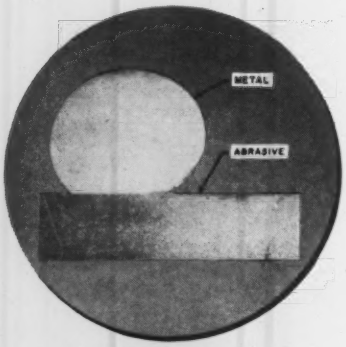


Fig. 2 A metal-abrasive system in the high-temperature furnace at the start of a study. The temperatures used were those which might be produced in the actual grinding process.

Fig. 3 Photograph taken at the end of a 1500 C reaction study, showing the extent to which titanium has reacted with the aluminum - oxide abrasive block. Titanium has diffused into and corroded the specimen.

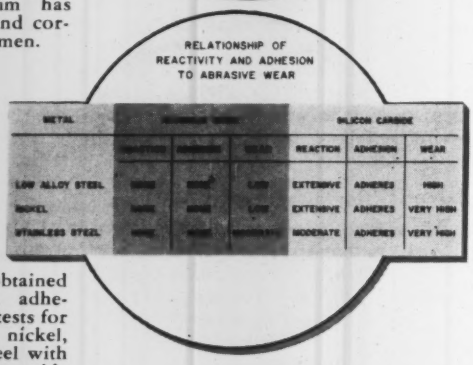


Fig. 4 Data obtained from reaction, adhesion, and wear tests for low-alloy steel, nickel, and stainless steel with both aluminum-oxide and silicon-carbide abrasive types

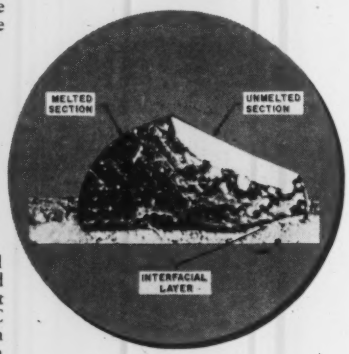


Fig. 5 Pure iron and silicon carbide heated in contact in an inert atmosphere at 1200 C for 30 min. Although a section of the iron remained solid, it showed effects of diffusion of silicon and carbon into the metal.

paper were run in argon atmosphere, except where noted. The furnace is equipped with a light source at one end of the chamber and a microscope at the other. A camera attachment is available for the microscope, thus permitting taking of either still or moving pictures. Fig. 2 is a picture of a typical metal-abrasive system in the furnace at the start of a reaction study.

The additional variable of pressure at temperature was realized in adhesion studies by alteration of the Leitz microscope furnace. The furnace section was detached from the microscope and positioned vertically above the bench top. High purity sintered alumina rods, $^1/_2$-in. diam, were used to support the samples and to transmit a static load of 2500 psi on the abrasive-metal combination during the furnacing operation. Visual observations could not be made under these furnacing conditions. Measurement of adhesion and determination of the existence of chemical reaction were carried out at the end of the furnacing step.

Fig. 3 shows the extent to which titanium reacts with aluminum oxide. Both pronounced compatibility and chemical reactivity are shown to exist between titanium and aluminum oxide at these elevated temperatures.

Virtually the same effect was observed when silicon carbide was substituted for aluminum oxide under similar reaction conditions. The temperature used in this test was selected because temperatures approaching the melting point of the metal are often produced in the actual grinding process.

Adhesion studies at high temperatures under pressure between titanium metal and the two abrasive materials give similar results to those observed in the reaction study alone. Titanium adheres very well to both aluminum oxide and silicon carbide under these conditions.

The destructive reaction of titanium metal on refractory oxides and on cutting tools of the tungsten-carbide type [4, 5] is well known.

Correlation With the Wear Rate

The same experimental technique was then used to investigate the extent to which work materials other than titanium react and adhere to aluminum oxide and silicon carbide. A second laboratory test method was employed to provide correlation of the reaction and adhesion studies with the wear rate of the abrasive on the work material. This procedure involved wear measurement on single-point tools mounted in a tool holder on a lathe used for cutting the work material. The abrasive point was accurately ground to a 90-deg wedge. Test conditions were such that the wear produced would be a result primarily of attrition rather than physical breakage. The length of scratch in the work material and measured wear of the abrasive point gave abrasive efficiency data for the system.

From Fig. 4 it can be seen that the purely attritive wear of an abrasive in dry grinding is directly related to the reaction between the abrasive and the metal. The metal-abrasive combinations that show extensive reaction, show high abrasive wear rate in cutting the metal. High adhesion between the metal and abrasive also leads to high abrasive wear rates. In general, chemically inert, nonadherent metal abrasive combinations exhibit low wear rates.

Although little reaction or adhesion is observed for aluminum oxide on stainless steel heated in an inert atmosphere such as argon, slight reaction with poor adhesion is found when the samples are heated in air.

Moderate wear is listed for aluminum oxide on stainless steel, and thus reflects not only the slight attritious wear possible, but also some microscopic chipping, or fracture wear. While the attritive wear appeared to be the lesser of the two, it was not possible to measure the separate contributions of physical breakdown and attritive wear.

Numerous other abrasive-work systems were evaluated. The same basic relationships between chemical reactivity, adhesion, and wear exist in all cases. Aluminum oxide was found to react very little with any of the ferrous metal systems studied. No adherence was developed between these systems and aluminum oxide at the temperature limits of the study. As a result, the attritive wear rate of aluminum oxide on all ferrous metals is very low.

Where There Is Greater Reaction

In the silicon-carbide-ferrous systems, however, the relationship between wear rates and chemical reaction is more readily seen because the degree of reaction is higher. Fig. 5 shows the cross section of a specimen of pure iron and silicon carbide that was heated in contact in an inert atmosphere for one half hour at approximately 1200 C.

The upper section of the photograph shows the distorted hemisphere of molten iron resting on a plaque of silicon carbide. Hence the iron in contact with silicon carbide melted at a temperature approximately 300 C below its melting point. The rectangular section of the upright corner of the metal remained solid throughout the 30 min. Although this section has remained solid, it nevertheless shows the effect of the diffusion of silicon and carbon into the metal. This fact is evidenced by the formation of carbon-containing pearlite in the metal which previous to the heat treatment was free of carbon.

The vigorous attack on the abrasive is obvious at the interface between the iron and silicon carbide. Examination of this section at high magnification shows that the abrasive is going into solution in the metal. Carbon precipitation in the form of graphite can also be observed at this interface. Thus silicon carbide can be expected to wear rapidly in grinding pure iron and would not be efficient as an abrasive for grinding operations for this metal in which stock removal is a prerequisite.

However, silicon carbide is often used for grinding various cast irons. Both silicon and carbon are soluble in pure iron in various percentages. The ease with which silicon carbide is attacked by ferrous metals is dependent upon the silicon and carbon content already present in the metal. The data in Fig. 6 show that the cast irons having sufficient silicon and carbon present do not dissolve the silicon carbide nor do they adhere appreciably to this abrasive. The observed wear rate consequently is low and hence silicon carbide can be used to grind these cast irons efficiently.

The degree of reaction, adhesion, and wear of aluminum oxide with the same materials is also shown in Fig. 6 to be quite low. Consequently, aluminum oxide can also be considered an efficient abrasive for these iron types.

Selection Through High-Temperature Studies

High-temperature studies can be used to select improved abrasive materials whenever conditions are met in grinding in which chemical reactions contribute

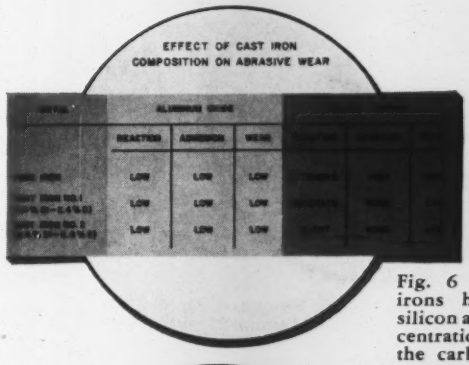


Fig. 6 Data on cast irons having various silicon and carbon concentrations. As either the carbon or silicon content of the ferrous metal increases, the rate of attack of the silicon carbide becomes less.

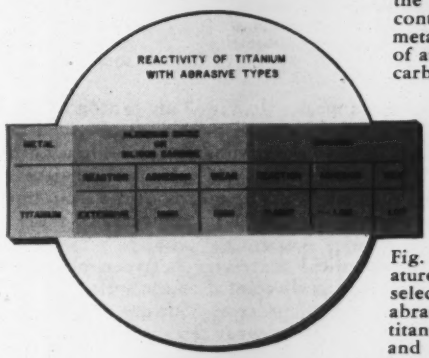


Fig. 7 A high-temperature study enabling selection of the right abrasive for grinding titanium. Reaction and adhesion will be less with zirconia; hence the wear rate is lower.

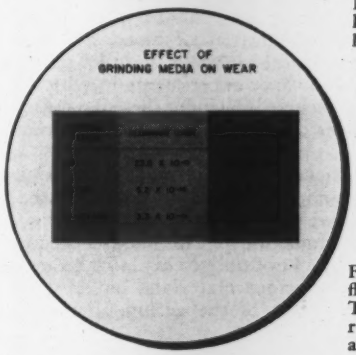


Fig. 8 Introducing a fluid into the system. The chart shows the relationship between abrasive composition, grinding media, and wear of abrasive materials in cutting cast iron.

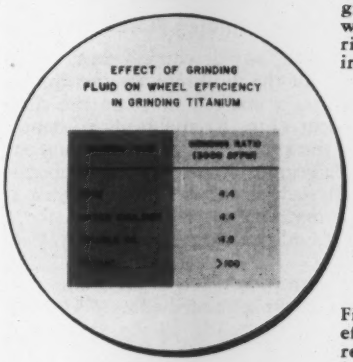


Fig. 9 Showing the effect of a completely reactive grinding fluid in the grinding of titanium with silicon-carbide wheels, increasing the grinding ratio by a factor of 25

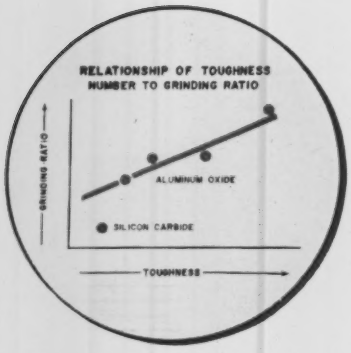


Fig. 10 Introducing "toughness number," an additional measure of the physical properties desirable in an abrasive. Grinding ratio is the volume of metal removed per unit volume of wheel lost.

Fig. 11 Abrasive - particle homogeneity and crystal habit affect the resistance to breakdown. Here are porous, single-crystal, aluminum-oxide grains, comparatively low in toughness number.

Fig. 12 Dense, single-crystal, aluminum - oxide abrasive grains. Here, the dense structure results in a toughness number higher than that of the porous crystalline structure in Fig. 11.

materially to abrasive wear. In Fig. 7 are tabulated the results of reaction, adhesion, and wear tests obtained in the investigation of three abrasive materials—aluminum oxide, silicon carbide, and zirconia—with titanium metal. The data predict that the wear rate of zirconia on titanium metal will be lower. This effect is confirmed in actual practice.

The degree of chemical reactivity between abrasive and work material is directly related to the surface finish obtained in the grinding process. Surface finish improved in all instances in the wear tests when chemical reactions caused wear. A high luster arose with high wear, presumably because the rounded points were not removing appreciable quantities of metal and were in effect burnishing the metal surface. A duller finish was invariably observed in those experiments in which little chemical reactivity occurred. Under these circumstances the abrasive remains sharp and consequently removes more metal.

The degrees of chemical reactivity and adhesion between the abrasive and the work govern both the efficiency of the abrasive and the type of finish produced. The laboratory techniques used in this research to measure these effects can be used not only to explain the action of known abrasives on various materials, but also can be applied to the prediction of the action of new, hard, refractory substances.

Chemical Reactions With Grinding Fluids

The use of a grinding aid or cutting fluid alters the reaction conditions, for the fluid replaces the air or inert atmosphere. This has a marked effect on the chemical reactions which occur (Fig. 8) and leads to control of the wear process of the abrasive to give maximum cutting efficiency and lower grinding costs. When a chemically inert grinding fluid such as oil is substituted for air at the abrasive-work material interface, the major effect is seen in the decreased reaction between abrasive and work material.

The addition of materials reactive with the work to the inert oil brings about an added effect. Under these circumstances less effort is made by the abrasive in removing stock because these reactive ingredients convert the work material (at the microscopic contacting spots on the gritwork interface) to lower shear-strength products. As in other metal-removal operations, the reduction of friction is accompanied by lower temperatures and greater tool life [6], with the "tools" in this case being the individual abrasive grains.

The substitution of water for oil can lead to additional chemical reactions in which the water takes part. Water, however, is one of the best cooling agents known. The addition of reactive chemicals to water, just as in the case of oil, materially reduces the wear rate of the abrasive and permits advantage to be taken of the superb cooling characteristics of water.

This is the basis upon which this Company's "Cimcool" water-base grinding fluids are manufactured. A completely reactive grinding fluid is recommended for titanium grinding since it markedly alters the chemical reaction occurring between the abrasive and titanium to the point where grinding this metal becomes a practical situation even with wheels containing silicon carbide as the abrasive. (Fig. 9.)

Further research into the chemistry of the grinding process is needed, in spite of the fact that a wide range of effective grinding fluids is available. This research will be the foundation for development of new, more efficient grinding fluids which will further improve grinding efficiency.

Physical Properties of Abrasive Wear

It has been shown that low abrasive wear can be realized where chemical reactions with the work are at a minimum or when something has been added to reduce the reaction rate. Inherent in this discussion was the fact that the materials under investigation possessed the necessary physical properties for an abrasive material. Certain physical properties are fundamental to an abrasive: hardness of high melting point. However, measurements of these properties alone are inadequate for selection of an efficient abrasive material, even when it has been established that the chemical composition is such that reaction will not occur in the grinding operation.

One convenient measurement used in the laboratory is termed "toughness number." It is determined from resistance to breakdown of the material under impact loading.

Various methods may be used to bring about the size reduction of abrasive particles to establish toughness number. Both ball milling and projection of the abrasive particle against a hard surface are convenient techniques. The difference between the initial particle size and the

Fig. 13 Dense, multicrystalline, aluminum-oxide abrasive grains, with toughness number still higher than that in Fig. 11. Both porosity and crystal habit contribute to an abrasive's resistance to wear.

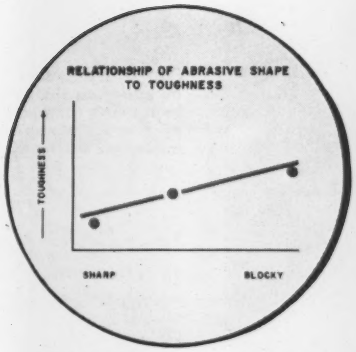


Fig. 14 Particle shape affects the toughness number and therefore the grinding ratio. Sharp, medium, and blocky-shaped grains were tested. Wheels were made to check the grinding ratios.

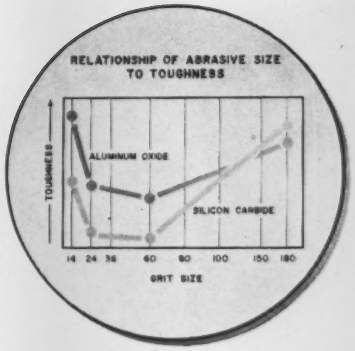


Fig. 15 Toughness number as a function of particle size. While silicon carbide is inherently tougher than aluminum oxide, it proves lower in the course-grit sizes, due to porosity and shape factors.

size after being subjected to either of these treatments is used to calculate the toughness number of the material.

A high toughness number arises from a low percentage breakdown of particles in the test and hence is indicative of high resistance to breakdown of the abrasive in grinding. Fig. 10 shows the relationship between the toughness number of abrasive materials and grinding ratios obtained in cutting low carbon steel. Grinding ratio is the ratio of volume of metal removed for a unit volume of wheel lost. In this case, it represents the cubic inches of steel cut per cubic inch of wheel used in the test.

A high grinding ratio is indicative of high resistance to breakdown of the abrasive. In Fig. 10 it can be seen that a direct relationship exists in the aluminum oxide abrasive system between the toughness number of the abrasive and the grinding ratio obtained in the cutting tests. An abrasive having a low toughness number gives a low grinding ratio, and one having a high toughness number gives a product having a high grinding ratio.

This relationship does not exist for the silicon-carbide abrasive material in grinding low carbon steel. The grinding ratio determined in these tests was far too low for the toughness number of this abrasive material. The explanation for the direct correlation between toughness number and grinding ratio in the aluminum oxide abrasive system and the lack of correlation with the silicon carbide abrasive, lies in the chemical reactivity of the specific abrasive-metal systems. Aluminum oxide neither reacts with nor adheres to low carbon steel. Consequently, the direct relationship is obtained between toughness number and grinding ratio. Silicon carbide reacts with and adheres to low carbon steel. This reactivity leads to rapid wear of the abrasive in the metal cutting operation and this chemical wear causes a low wheel efficiency and hence a low grinding ratio.

Contributing to the Toughness Number

Certain physical properties of an abrasive system can be shown to contribute directly to the toughness number. Abrasive particle homogeneity and crystal habit affect the resistance to breakdown under these test conditions. Figs. 11, 12, and 13 illustrate this for aluminum-oxide abrasive. The toughness numbers of these three types of aluminum oxide increase in order, from a low value for the porous single-crystalline material, to a medium high value for the dense single-crystalline particle, to a very high value for the dense multicrystalline abrasive grain. Hence both particle porosity and crystal habit contribute to abrasive toughness and hence its resistance to wear in the grinding process.

Particle shape likewise affects the toughness number and therefore the grinding ratio of the wheel. A sample of abrasive grains was separated on a precision laboratory classifier into three fractions, namely, sharp, medium, and blocky-shaped grains. Toughness number was determined for each abrasive fraction, Fig. 14. Wheels were also made for cutting tests.

It can be seen that a low toughness number was obtained from the sharp, slivery abrasive and a high toughness number from the blocky abrasive sample. A correspondingly low grinding ratio was secured from the wheel containing the sharp material and a high grinding ratio from the wheel made with the blocky abrasive.

One other relationship between abrasive materials was established: The toughness number as a function of abrasive size. It can be seen from Fig. 15 that silicon carbide is tougher than aluminum oxide in abrasive sizes 150 grit and finer. The greater inherent toughness of silicon carbide has been indicated also from studies in lapping of brass and steel [7].

Acknowledgment

The major part of the diffusion and adhesion studies reported here were carried out by Dr. G. R. Pulliam while Research Supervisor, Chemistry and Abrasives Research Department. He is now affiliated with North American Aviation, Inc.

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Fig. 1 Apparatus used for lateral-vibration tests; rings can be added to the flywheel, and the amount of overhang varied by moving the outboard bearing. Variable torque is supplied by the air compressor, and torsional shaft disturbance is measured with a Geiger torsiograph.

Since any vibration is a source of stress, the causes, effects, and remedies for lateral vibration or "whirl" of shafts in rotating electrical, mechanical, and hydraulic machinery are important

Lateral Vibrations in Reciprocating Machinery

By C. M. Lowell, Assoc. Mem. ASME, Engineering Supervisor, Worthington Corporation, Buffalo, N. Y.

LATERAL VIBRATION of shafts, or "whirling" as it is sometimes called, has been investigated by many experimenters [1–5].[1] Most previous investigations have been concerned with rotative speeds equal to fundamental frequencies. Experimentation has been confined to rotative machinery such as multistage turbines, centrifugal pumps and compressors, and to electrical machinery.

Whirl is merely a lateral vibration superimposed upon rotation. Normal whirl in rotating machinery occurs at or near the corresponding rotative frequency. It is evidenced by rotation of the shaft in a bowed position like a skipping rope. Where no gyroscopic effect of the rotating masses is encountered, this lateral natural frequency is the same for any speed. This would be the case for a mass-shaft system where the shaft is uniform and supported identically at both ends with the concentrated mass in the exact center. In the test apparatus to be described, the mass was overhung, therefore the whirling natural frequency was modified by the gyroscopic component, Fig. 1.

The mass of the flywheel in the test apparatus deflected the shaft downward while the gyroscopic component tended to straighten it. Since natural frequency is a function of deflection, the gyroscopic component tends to decrease the deflection and thus raise the lateral natural frequency as the rotative speed is increased. This lateral or whirling natural frequency is known as forward whirl.

Reverse whirl is caused by a change in algebraic sign of the gyroscopic component. It acts in a direction which tends to cause the shaft to deflect still more than the deflection caused by the flywheel mass. This causes a reduction in natural frequency as the rotative speed is increased. Reverse whirl can be observed if there are disturbing forces in the rotative system which coincide with the natural frequency of the reverse whirl.

A series of tests was made with an adjustable flywheel to which rings could be added, and on which the amount of overhang of the flywheel could be varied by moving the outboard bearing. A 5-in-bore by 5-in-stroke double-acting air compressor was used as a source of variable torque at twice a revolution to the shaft attached to it. Torsional shaft disturbance was measured with a Geiger torsiograph from a pulley adjacent to the compressor.

Whirl charts were also made by tracing the deflection of the shaft against a fixed pencil, Fig. 2. At speeds where no whirl was present, perfect circles appeared on the card. The 2nd, 3rd, and 4th-order whirl patterns appeared as ellipses, 3 and 4-sided figures, respectively. The repetitive nature of the figures indicated a regular cyclic movement.

The relationship of the magnitude of torsional cyclic input as measured by the torsiograph to the amplitude

[1] Numbers in brackets designate References at end of paper.

Contributed by the Machine Design Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 58—A-79.

Table 1 Tabulated Data for Light-Flywheel (2 Rings) Tests on a $1\,^{3}/_{16}$-in-Diam Shaft

Dimension *a*, in. of overhang	Dimension *b*	Whirl order and direction (forward or reverse)	Rotative speed, rpm	Lateral[1] natural frequency f_l, vibrations per min	Single amplitude, in.	Ratio, f_l/f_t	Lateral natural frequency at rest, vibrations per min
10.59	10.875	3F	310	930	0.024	0.912	900
"	"	2R	405	810	0.040	0.757	"
"	"	2F	480	960	0.062	0.941	"
8.34	13.125	4R	255	1020	0.045	1.000	1100
"	"	3R	330	990	0.022	0.970	"
"	"	3F	385	1155	0.022	1.132	"
"	"	2R	480	960	0.061	0.940	"
"	"	2F	635	1270	0.062	1.245	"
7.215	14.250	3R	380	1140	0.012	1.118	1240
"	"	3F	450	1350	0.012	1.332	"
"	"	2R	550	1100	—	1.080	"

[1] Torsional natural frequency f_t, vibrations per min, 1020.

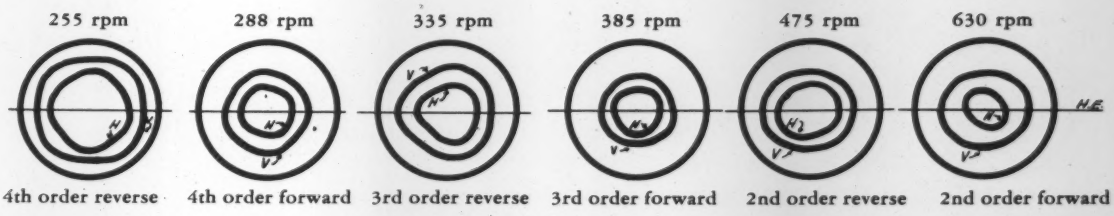

Fig. 2 Whirl card patterns were made by tracing the deflection of the shaft against a fixed pencil. Perfect circles appear where no whirl was present. Elliptical patterns indicate the various orders of whirl. Head end at right in all cases.

of whirl as measured on whirl cards is shown in Tables 1 and 2. The effect of proximity of torsional and lateral natural frequencies on whirl magnitude appears quite noticeably. Amplitudes of whirl have all been corrected to a common distance from the outboard bearing for a direct comparison.

The conclusions drawn from the series of tests can be summarized as follows: (*a*) Any periodic torque applied to a shaft driving an overhung flywheel mass will tend to excite a lateral vibration or whirl in the elastic system; (*b*) when torsional and lateral natural frequencies of a mass-shaft system are close to each other, any periodic torque tending to excite a harmonic order, however small, of the torsional natural frequency will likewise excite the lateral natural frequency; (*c*) if possible, torsional and lateral natural frequencies should be separated as far apart as possible to insure no excitation of lateral vibration, this being particularly true if strong torsional orders occur within the operating range.

Torsional disturbances can cause lateral vibration in a shaft system as described. An overhung flywheel is particularly susceptible to this phenomenon because of its relatively low lateral natural frequency. The principal causes of cyclic torsional disturbances are torsional vibration and cyclic irregularity. Both of these frequencies can be readily calculated in advance. Cyclic irregularity or torque variation will have a frequency which varies directly with rotative speed. If the product of the number of torque variations per revolution and the revolutions per minute of rotative speed approaches the lateral natural frequency of the flywheel-shaft system, lateral vibration can result. In this instance, the torque variation will act in the same manner as torsional vibration.

The equations developed by E. Downham [5] can be relied upon to yield natural-frequency values close to the actual values. By a preliminary calculation of torsional natural frequency, torque-variation frequency, and lateral natural frequency, shaft and flywheel sizes can be chosen such that torsional-disturbance frequencies and lateral-whirling frequency can be sufficiently separated.

Some crankshaft failures have been encountered which can be at least partly attributed to additional bending stress caused by whirl. Fortunately, either the torsional disturbance must be strong or the torsional and lateral natural frequencies practically in resonance before sufficient lateral vibration to cause trouble occurs. Small lateral vibrations have been observed in many types of reciprocating machinery, even when outboard bearings were used for flywheel support. No serious additional stress was caused because a condition of resonance did not exist.

These studies should be of value to engine and compressor builders as well as to manufacturers of other types of medium and high-speed heavy reciprocating machinery.

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Table 2 Tabulated Data for Heavy-Flywheel (3 Rings) Tests on a $1^3/_{16}$-in-diam Shaft

Dimension *a*, in. of overhang	Dimension *b*	Whirl order and direction (forward or reverse)	Rotative speed, rpm	Lateral[1] natural frequency f_l, vibrations per min	Single amplitude in.	Ratio, f_l/f_t	Lateral natural frequency at rest, vibrations per min
11.19	10.875	2R	335	670	0.030	0.721	730
"	"	2F	395	790	0.058	0.850	"
"	"	1R	625	625	—	0.616	"
9.44	12.625	3R	260	780	0.022	0.838	850
"	"	2R	380	760	0.050	0.818	"
8.94	13.125	3R	285	855	0.038	0.893	925
"	"	3F	330	990	0.022	1.065	"
"	"	2R	420	840	0.065	0.903	"
"	"	2F	530	1060	0.076	1.140	"
7.815	14.250	3R	310	930	0.019	1.000	1030
"	"	3F	380	1140	0.016	1.225	"
"	"	2R	440	880	0.074	0.947	"
"	"	2F	605	1210	0.050	1.300	"

[1] Torsional natural frequency f_t, vibrations per min, 930.

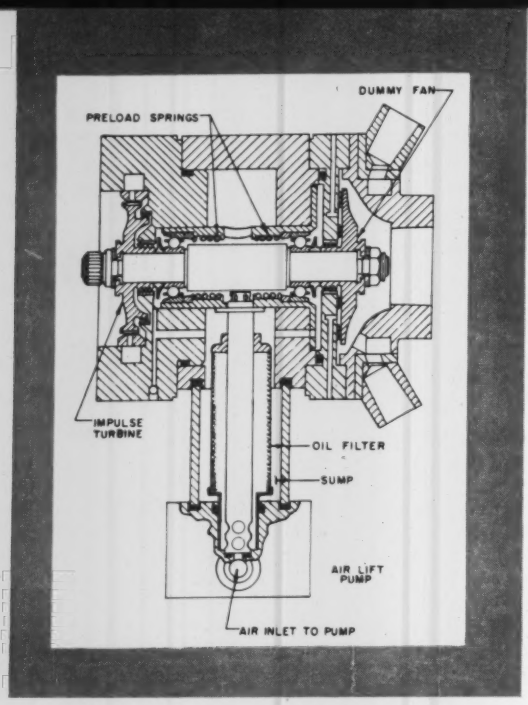


Fig. 1 High-speed bearing test rig consisting of a simple overhung air-driven turbine supported by two ball bearings and a dummy wheel mass fitted at the other end of the shaft

Bearing and Seal Development

By Stanley Gray

Systems Engineer,
Stratos Division,
Fairchild Engine and
Airplane Corporation,
Bay Shore, N. Y.

Some current research by an aircraft-accessory manufacturer on bearings for operation up to 140,000 rpm and 1000 F, and on the unusual lubricants and seals needed

THE investigations reported cover:

1 Operation of bearings at speeds to 140,000 rpm with reference to lubricants suitable for bearing temperatures to 625 F and problems of wear and vibration.

2 Development of 1000-F bearings of several high-temperature materials with reference to the value of powdered lubricants, capacity, wear, and friction.

3 The dry operation of high-speed, high-temperature shaft seals. (The author also dealt in some detail with the following items, which have been condensed or eliminated in the editing but are available in the pamphlet publication of the paper—Ed.:

4 Oil-throwaway lubrication of bearings at 800 F using conventional type lubricants.

5 The use of Freon-12 refrigerant in the liquid and vapor phases as a bearing lubricant at −18 to +1000 F.

6 Development of a Freon-12 shaft-seal design for an aircraft-type refrigeration compressor.)

High-Speed Bearings

An investigation of the operation of small oil-lubricated accessory-size ball bearings at extremes of speed and temperature covered various types of bearings, new high-temperature lubricants, and the effect of high-speed operation on wear and vibration. A complete assembly of bearings, shaft, wheels, and lubrication system was used in the test rig.

Apparatus. One of the test units, Fig. 1, consisted of a simple overhung air-driven turbine supported by two ball bearings, and a dummy wheel mass fitted at the other end of the shaft. Operating temperature was achieved by driving the turbine with preheated air.

An air-lift pump used a very small quantity of low-pressure air to bubble the oil up a tube into the bearing cartridge. This formed an air-oil mist which was induced through the bearings by suction slingers outboard of the bearings. The oil was then returned to the unit sump. For long runs (100 hr) at high temperatures, a supplementary oil supply was connected to the unit to compensate for evaporation and leakage losses.

Bearings. The unit was designed to use a pair of 12 or 10-mm-bore-size angular contact-type bearings, which were spring-loaded and arranged for taking thrust in either direction. One bearing arrangement under investigation is the integral-shaft design in which the inner raceways are ground directly onto the shaft. Two alternative arrangements of such shafts are shown in Fig. 2. Some of the advantages with this design compared with conventional bearings and shafts are: (*a*) A smaller bearing can be used for a given shaft size and stiffness, (*b*) two possible concentricity errors per bearing are eliminated, and (*c*) greater heat dissipation from the bearings into the mass of the shaft is achieved. The bearing materials used in this work were SAE 52100, AISI 440C stainless, and Halmo tool steel.

Method of test. The test unit was operated during a normal day period and maintained at the desired constant speed and temperature by adjusting the turbine air flow and air heaters. During the high-speed investigations, a vibration scan was made over the full-speed range, readings were taken at the bearings in terms of

[1] Numbers in brackets designate References at end of paper.

Contributed by the Lubrication Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and presented at the ASLE-ASME Lubrication Conference, Los Angeles, Calif., October 13–15, 1958. Condensed from Paper No. 58—Lub-10.

unbalance acceleration (forces expressed in g), and these were measured by attaching an acceleration pickup to the bearing cartridge and using a Panoramic analyzer to obtain the g-level.

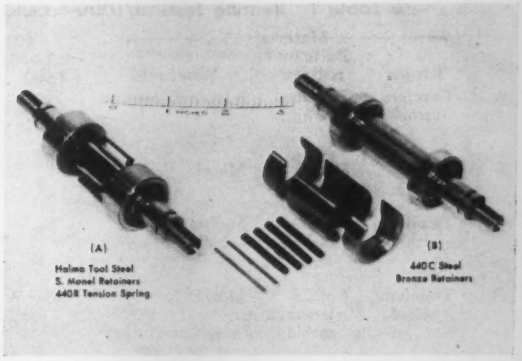
Results. *Tests at high temperature.* Tests were made with outer-bearing-race temperatures of 500 to 625 F at speeds up to 110,000 rpm on lubricants of the MIL-L-9236 (proposal) and silicone types. Figs. 3 and 4 show bearings and unit after test.

Most of the problems in extended high-temperature operation are associated with evaporation breakdown and coking of the lubricants. The presence of air will use up the oxidation inhibitors contained in the lubricants and accelerate the breakdown. The coking causes sticking of the bearings in the cartridge causing them to take up a fixed position, usually corresponding to the high-temperature, high-speed running condition; this nullifies the effect of the preloading springs. When sticking occurs the result is audible; and if the unit is restarted cold the bearings run noisy until the high temperature and speed condition is attained. It says much for the bearings that operation is possible under these conditions. The well-established bearing arrangement may not be the most satisfactory for extreme temperature operation [1, 2, 3][1] because of this sticking.

Tests at extreme speed. Two problems experienced at extreme speed were bearing ring to retainer wear and vibration. With a change from 52100 steel to 440C stainless steel for high-temperature operation, severe wear was encountered between the retainer and the retainer locating land on the bore of the outer race. Fig. 5 shows the wear experienced with one bearing of 440C against a bronze retainer at 110,000 rpm using MIL-L-6085A oil. The type of oil and the test temperature were not found to be significant factors, and operation of the same type bearing of 52100 created no wear problem. Further evaluation shows that the problem also exists with other manufacturer's designs.

The bearing manufacturer had modified the retainer of the bearing shown in Fig. 5 to overcome the extreme speed difficulty. One effect was a reduction of possible retainer whirl.

Failures also were experienced at extreme speeds as a result of vibration. Operation of standard 12-mm-bore size ball bearings at 125,000 rpm or higher led to failure after approximately 12 hr, characterized by heavy unbalance wear on the bearing inner race, Fig. 6. Vibration measurements taken over the speed range with standard bearings show a first-order unbalance of the type illustrated in Fig. 7 (*a*). Change in wheel masses, stiffening the bearing cartridge, increasing spring preload, and double balancing gave no improvement in life.



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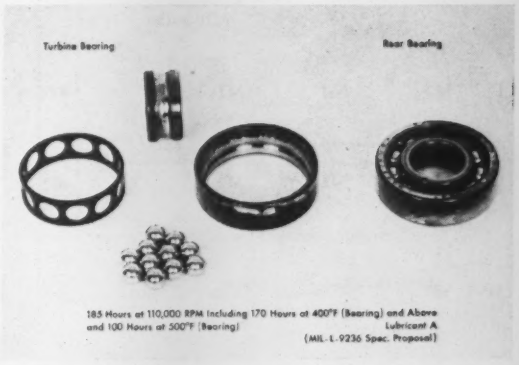
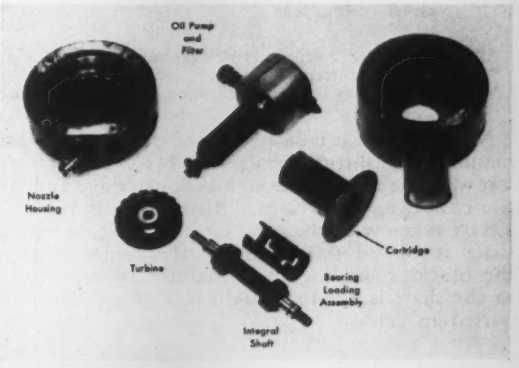

Turbine Bearing
Rear Bearing
185 Hours at 110,000 RPM Including 170 Hours at 400°F (Bearing) and Above and 100 Hours at 500°F (Bearing)
Lubricant A
(MIL-L-9236 Spec. Proposal)

3



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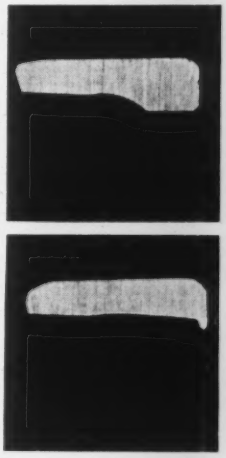

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6

Fig. 2 Two alternative arrangements of integral shaft bearings in which the inner raceways are ground directly onto the shaft

Fig. 3 Bearings and unit after 185 hr at 110,000 rpm including 170 hr at 400 F (bearing) and above, and 100 hr at 500 F (bearing) with lubricant A, MIL-L-9236 spec. proposal

Fig. 4 Unit after 500-F test on lubricant B, MIL-L-9236 spec. proposal, 156 hr total, including 80 at 500 F, and 35 at 450 F

Fig. 5 Outer-ring wear at retainer-location land compared with new bearing; material was 440C, time was 20 min at 110,000 rpm

Fig. 6 Bearing inner-ring wear after 12-hr run at 125,000 rpm ($DN = 1.5 \times 106$, where D is the bearing bore in millimeters, and N is the speed in rpm)

Table 1 Bearing Tests at 1000-F Outer-Race Temperature—None or Powdered Lubricants

	Materials			Load, lb		Peak[b]	No. of		
	Rings	Balls or rollers[a]	Retainers	Radial	Thrust	rpm	cycles	Lubricant[c]	Remarks
A	Titanium carbide	Titanium carbide	S Inconel (cast)	75	5	22000	44	None	Retainer failure causing extensive damage, pickup of retainer material on other parts
B	M10	M10	Monel	75	5	22000	252	None	Retainer failure due to mechanical weakness and wear
C	Titanium carbide	Titanium carbide	Stellite 3 spacer balls	75	25	22000	80	None	Test stopped for heavy waisting of spacer balls, rings in good condition, balls slight surface damage
D	Titanium carbide	Rollers, titanium carbide	Inconel X	525	5	22000	284	None	Bearing breakup due to retainer lug entering race, retainer material gave good performance
E	M10	M10	Full complement M10 balls	525	25	22000	550	None	No failure, high polish on all contact parts, outer race yielding, 0.0005 in. wear on balls, 0.002 in. on inner race
F	M2	M2	M2	400	25	9500	1 hr	[d]Metal-free phthalocyanine	All parts in excellent condition with high polish on contact surfaces, slight oxidation on retainer surfaces, negligible wear
G	M2	M2	M2	400	55	8000	2400	Lead oxide (PbO)	Bearing in good condition, high polish on contact surfaces, some build up of lead oxide, slight oxidation of retainer, negligible wear
H	M2	Titanium carbide	S Inconel (cast)	275	18	8000	250	60% Graphite + 40% CdO	Bearing in very good condition little wear or scratches small metallic deposits from lubricants, no wear
I	Titanium carbide	Titanium carbide	M1 electrolized	600	25	8000	220	[d]Metal-free phthalocyanine	No failure, retainer excellent, microscopic surface damage on raceways and balls

All 204 size (20-mm bore) except H, 203 size (17-mm bore).
[a] All ball bearings except D.
[b] In cycles consisting of rapid acceleration and deceleration lasting 2 to 3 sec, except F, where operation was constant.
[c] Air used as carrier with powdered lubricants.
[d] Patents pending.

No problem was indicated in the traces taken from the running of an integral shaft, Fig. 7 (*b*). Features of this test were the use of a through-bore cartridge and 10-mm size of bearing outer rings. Also shown in Fig. 7 (*b*) is a trace taken with the same integral shaft, in which the shaft is bowed 0.0015 in. at the center relative to the bearings, leading to premature failure. The bow in the shaft is due to a slight lack of squareness in the nutted-up parts.

1000-F Bearing Development

Considerable effort is being made to solve the problems of operating bearings at 1000 F and higher [4, 5, and 6]. The aim is to establish performance and design data on selected bearing materials, different bearing types, and some of the possible lubricants.

Apparatus. A single-bearing test rig for bearings up to 25-mm-bore size was driven from an aircraft-accessory-type power turbine capable of 25,000 rpm. The rig-support bearings were oil-cooled and lubricated.

The test bearing was secured to an overhung shaft and loaded radially through a 10 to 1 lever system, enabling 1000-lb loads to be applied to the test bearing; thrust load was applied directly via a cable-and-pulley system. Test temperature was achieved by passing 1000-F air directly over the bearing.

Bearings were either operated with no lubrication or with powdered-type lubricants. Where powders were used, they were injected into the bearing during test using heated air as a carrier, either immediately before each acceleration cycle, or at a frequency of up to 12 injections per min, if the bearing was run continuously.

The lubrication system consisted of a timer-controlled solenoid valve in the air line to the container holding the powder and a settling chamber; this chamber was fitted after the container to separate out the larger heavier particles. The finer powder reached the bearings in the form of a light smoke.

Bearings. In these tests, 17 and 20-mm-bore-size ball and roller bearings made from tool steel, titanium carbide, and Stellite, with various retainer materials were used. Table 2 details the bearings.

Method of test. The rig and bearing are heated to the desired temperature and the test is then run at the operating speed with progressively increasing loads, up to the required test load, and then the endurance test commences. The bearing is examined periodically during a test program, readings are taken of bearing temperature, speed, and lubricant flow, if applicable. The results are evaluated in terms of damage, wear, or build-up of lubricant deposits, Table 1.

Discussion of results. *Operation without lubrication.* For highly loaded high-speed bearings, excessive wear, and retainer failures presented the main difficulties. In nonlubricated tests, the best result was obtained with an M 10 tool-steel bearing, having a full ball complement, but the amount of wear was still not acceptable.

Tests with 5/16-in-bore-size M 1 tool-steel needle roller bearings indicated that thousands of speed cycles (to 22,000 rpm) under light loads were possible without objectionable wear.

Operation with powdered lubricants. Results of tests with powdered lubricants are encouraging [7, 8] and a study of Table 1 leaves no doubt of the benefits which can be gained by this method. Test (F), with the 20-mm, M2 tool-steel bearing, operating continuously at 9500 rpm under a 400-lb radial load should be compared with the catalog rating of a standard oil-lubricated bearing. The result could not be achieved without the powdered lubricant. In using powdered-type lubricants, a minimum quantity should be injected into the bearing. In the foregoing test there were 12 injections per minute at a total rate of about 0.03 oz per hr.

Some of the limitations and problems with the powders included build-up in the bearing raceways and a narrow temperature band of efficient lubrication. The latter difficulty might be overcome by combining various powders to span the temperature range.

Bearing materials. For high capacity, and for temperatures not exceeding 1000 F, tool steel is the best proved type of material, although oxidation is sometimes a problem with softer retainers of this material. Sintered-carbide materials are particularly important because of their potential for higher temperatures, their excellent resistance to oxidation and corrosion, and hot hardness, although there are problems with brittleness, surface porosity, and microscopic surface damage. Stellite-type materials also have many important high-temperature properties, and recent tests with the harder grades of Stellite show encouraging results at 1000 F, comparable with tool-steel bearings. The selection of retainer material is less critical with powdered-lubricant operation than with unlubricated operation.

Bearing friction. Important in high-temperature drives, particularly without lubrication, is the power required to drive loaded bearings. Fig. 8 shows some data not detailed here on the frictional losses in a non-lubricated thrust bearing at high temperature compared with a similar oil-lubricated bearing at normal temperature.

Conclusions. This work indicates that for specific types of equipment and conditions of operation, highly rated rolling-contact bearings can be used successfully at 1000 F. Operation without lubrication is possible under moderate loads and/or speeds but limited life from undue wear may be a problem.

The use of intermittently injected powdered-type lubricants is an important factor. Some recent development work has shown that, with an air carrier, powders can be used in complex equipment to lubricate multiple bearings and gears, and may be preferable to any 1000-F liquid lubricants with their anticipated pumping, sealing, fire hazard, and corrosion difficulties.

Extreme-Temperature Liquid-Lubricant Operation

The once-through oil-throwaway technique is being investigated for high-speed ball bearings operating at 700 F and higher, particularly for relatively-short-life applications such as missile components. Lubricant in a liquid state is pumped to a jet which is as close to the bearing as possible. When the lubricant leaves the jet, it flashes to vapor, giving both lubrication and some

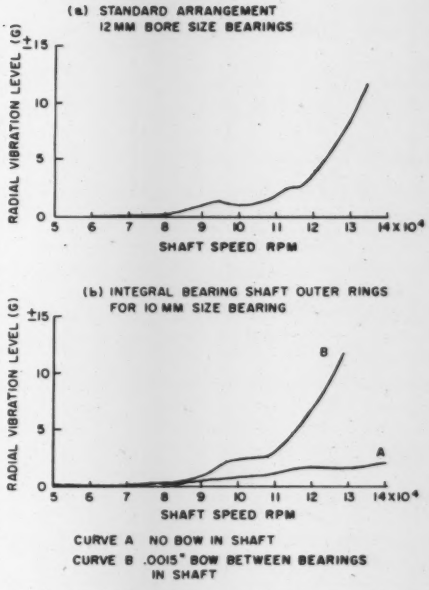

Fig. 7 Plot of vibration level against shaft speed

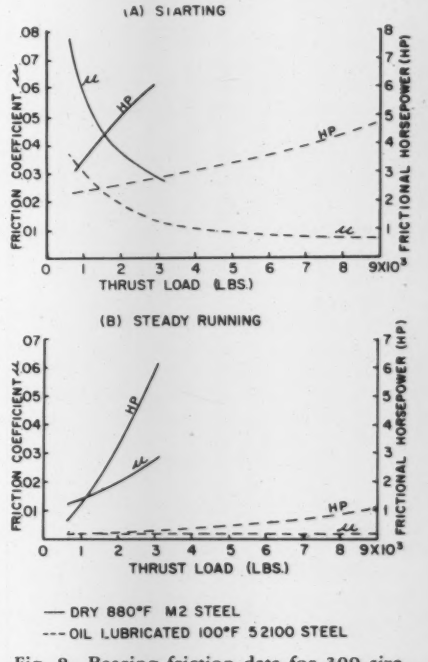

Fig. 8 Bearing friction data for 309 size, 45-mm bore, speed 3520 rpm

Table 2 High-Speed Dry-Seal Material Tests

Rotor material	Stator material	Hours of test	Face pressure, psi	P. V. factor psi × fpm	Temperature Ambient, deg F	Temperature Stator rear face, deg F	Wear, in. Rotor	Wear, in. Stator	Remarks
Titanium carbide	Titanium carbide	1/2	16	218000	220	—	0.0004	0	Smooth wear pattern but not optimum combination
Tungsten carbide	Tungsten carbide	3	16	218000	500	650	0.00002	0.00005	Excellent wear pattern both parts, slight discoloration
Tungsten carbide	"1000-F" carbon graphite	3	15	195000	525	660	0	0.005	Good wear pattern, amount of carbon wear high

All tests at 52000 rpm (13,500 fpm) with continuous running time

cooling effect. Preliminary data show that operation of bearings on liquid lubricants at 800 F is feasible, but the selection of the lubricant is difficult. It must give the minimum deposit on vaporization or at any intermediate temperatures. It must have the highest critical temperature to prevent boiling and vaporizing if preheated in the delivery line to the jet. This would block the flow of liquid lubricant and could not be corrected by increasing pump pressure. The lubricant vapor must drive all air from the bearing housing and reduce in temperature before contacting air again, otherwise burning may occur.

The investigation of more unusual types of lubricants and combinations of liquids and powders is continuing.

Freon 12 as a Bearing Lubricant

Investigations were made into the operation of rolling-contact-type bearings using Freon 12 (difluorodichloromethane) as a low-viscosity lubricant with particular reference to the possibilities of an "oil-less" refrigeration system and an interest in the use of the substance as a high-temperature vapor-phase lubricant. Under the test circumstances, operation of ball bearings over a temperature range of 110 to 1000 F on vapor Freon 12 was shown not to be feasible. With care in the selection of bearing-retainer materials low-viscosity liquid Freon 12 could be used under defined conditions.

Operation of High-Speed Dry Seals

The provision of a high-speed rotating-face-type shaft seal which would normally seal the jet fuel in an aircraft pump was investigated. The seal would operate dry under certain circumstances at two to three times the normal shaft speed in an ambient temperature of 500 F, but after the overspeed condition the original sealing efficiency with the jet fuel would again be required. Tests were made by mating together selected materials as high-speed pairs, and their dry-operating characteristics were investigated with an air-turbine-driven test rig. A stationary nose-type mating ring was loaded by air pressure against the rotor, and operating temperature was achieved by passing heated air through the seal housing. Readings were taken of temperature, surface wear, and damage at a test speed of 52,000 rpm (13,000 fpm) with the results shown in Table 2. Other work of this nature is being done [10, 11, and 12].

Dry operation of selected mating materials for several hours during emergency overspeed conditions was found to be feasible, providing careful control is maintained on face pressures and PV ratings.

In these tests the newer "1000-F" carbon-graphite nose in conjunction with carbide-type materials was the most attractive. Possibly carbon graphite against itself would also give excellent performance.

Conclusions. Construction of a complete seal reveals that the seal-leakage requirements can be met when operating on fuel, after the emergency-dry-running condition, and that a major problem is to achieve a satisfactory high-temperature secondary seal. A metallic bellows-type construction offers the most promise. However, with the friction during dry operation, great care is required in preventing vibration and torque affecting the thin bellows material. Use of the carbon-graphite-type materials gives good results, but the rate of wear under dry operation can be a problem particularly with a high-spring-rate bellows-type seal; possibly causing loss of face pressure.

Acknowledgments are due to the Stratos Division of the Fairchild Engine and Airplane Corporation; to T. H. Lindbom, former Chief Systems Engineer; and to C. Fedden and J. Amott of the Bearing and Seals Laboratory.

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The first full year of operation of the Philo 6 Unit[1] has been completed. Although some difficulties developed in the high-pressure-turbine performance,

Thermal Performance of the Philo Supercritical Unit

high-pressure feed pumps, and other lesser items, operational and test results show that the improved performance calculated in the design phases can be achieved in actual practice.

By A. S. Grimes,[2] Mem. ASME, and J. A. Tillinghast,[3] Mem. ASME
American Electric Power Service Corporation, New York, N. Y.

PERFORMANCE TESTS during the first full year of operation of the Philo 6 Unit indicate conclusively that the higher thermal performance calculated in the design phases, through the use of supercritical pressure, high temperatures, and multiple stages of reheat, can be achieved in actual operation. Detailed tests showed some areas of difficulty, such as in the high-pressure turbine performance, high-pressure feed pumps, and other lesser items.

Design Heat Balance

The thermodynamic studies made in 1952 and 1953, balanced by economic considerations and experienced judgment, indicated that supercritical pressure at the highest practical temperature was the correct direction for new generating capacity [1].[4] Metallurgically, 1150 F represented the maximum temperature that could be achieved with the materials then available, and an operating pressure of 4500 psi was selected since it appeared to bear a good thermodynamic relation to 1150 F, and because it fell within operating-pressure limits described within the ASME boiler code. Two stages of reheat—at 1050 and 1000 F—were added to obtain the highest cycle efficiency. The somewhat low reheat temperatures were dictated by the large flow volumes to be handled at the two reheat points.

Steam at 4500 psi and 1150 F is generated in the first Universal pressure steam generator operated in this country [2, 3]. Steam is twice reheated; first at 1200 psi to 1050 F, and then at 225 psi to 1000 F. Feedwater flows to the steam generator at 5500 psi and 525 F. The steam turbine is a tandem-compound, double-flow, 3600-rpm machine [4]. Feedwater is returned from the condenser to the steam generator through seven feedwater heaters and a split-feed pump arrangement. Reasons for selecting this cycle are given in [5].

Two major considerations bear on the final performance of the unit. The first was the decision to split the boiler feed pump into two sections. The first pump delivers water at approximately 2100 psi to two h-p feedwater heaters. The second pump takes water at 2100 psi and approximately 510 F and delivers it to the steam generator at 5500 psi. The other major decision made was to use a h-p turbine designed for steam cooling. Two rotors were made for the h-p turbine. The first was of stainless steel, which ultimately would require cooling only of the h-p inner shell and the h-p packing. The second was a ferritic rotor, which would require cooling of the first five rotor stages, the inner shell, and the h-p packing. Cooling steam for this service is obtained by feedwater attemperation of suitable quantities of main steam taken directly from the h-p-turbine leads.

Operation

Initial operation occurred on March 20, 1957 [6, 7, 8], following an extensive five-month period of cleanup and preliminary operation of the unit on its bypass system. This was longer than normal because of delay in delivery of the main generator. In the first few weeks, difficulty was experienced in sealing h-p-pump shafts against the h-p, high-temperature suction conditions. A significant factor was the removal of the artificially imposed 525 F limit on feedwater temperature—which had been dictated by steam-generator considerations relative to the location in the heating surface of the transition zone between water phase and steam phase—when the knowledge of water chemistry proved adequate. An increase to 566 F and removal of the orifice in the h-p-heater extraction line reduced unit net capability by 5.7 mw and improved net plant heat rate by 85 Btu per kwhr.

Steam-Generator Efficiency

The results of steam-generator efficiency tests at various loads as well as the design-efficiency curve used for heat-

[1] Located at Philo, Ohio, near Zanesville.
[2] Head, Results Section.
[3] Staff Engineer.
[4] Numbers in brackets designate References at end of paper.

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Thermal Performance of the Philo Supercritical Unit

balance calculations are shown in Fig. 1. The shape of the design curve was different because constant excess air at the steam-generator outlet and decreasing exit-gas temperature with load were expected. Actually, the excess air is held essentially constant at the cyclones so that outlet excess air increases as load decreases because of air leakage through idle cyclone-shutoff dampers and minor casing leakage. The outlet-gas temperature is held at approximately 335 F over the load range to prevent fouling of the air heaters. The coal normally burned was a sulfur content of approximately 5 per cent.

It is anticipated that the 75 per cent gas recirculation provided in the basic design can be reduced appreciably. This will reduce steam-generator auxiliary-power requirements by about 620 kw, at full load.

The total steam-generator pressure drop predicted by the designer proved highly accurate.

Feed-Pump Efficiency

Suction conditions at the h-p feedwater pumps at full load are approximately 550 F and 2100 psi. The floating Graphalloy bushings with very small diametral clearances provided for shaft sealing deformed, and the sleeves on the pump shafts scored. A more conventional sleeve-type bushing was applied with substantial amounts of cool-condensate injection to prevent flashing, Fig. 2. In this arrangement, 92,500 lb per hr of condensate at condenser temperature is injected in the l-p and h-p-pump shaft seals, thus bypassing all the l-p heaters. This is a thermal-cycle loss, since this feedwater is heated by deaerator steam rather than lower-pressure steam. In addition, 36,200 lb per hr of 2100-psi water is returned to the deaerator, displacing feed heating from the deaerator to the h-p and i-p heaters and requiring extra pumping power in the l-p pump. Calculations based on actual test runs indicate that, if leakages were eliminated with all other equipment performing as tested, gross turbine heat rate would be improved more than 15 Btu per kwhr. In addition, net plant output would increase more than 700 kw.

Plant tests indicated that the feed pumps under the conditions of Fig. 2 required approximately 1000 kw more of auxiliary power than would have been required with the originally estimated leakage and internal efficiency.

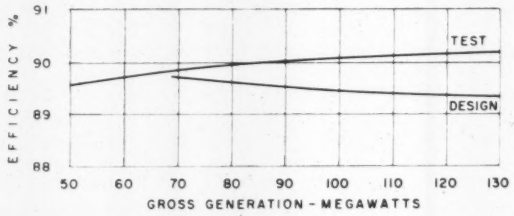

Fig. 1 Design and test boiler efficiency of the Philo supercritical-pressure unit 6

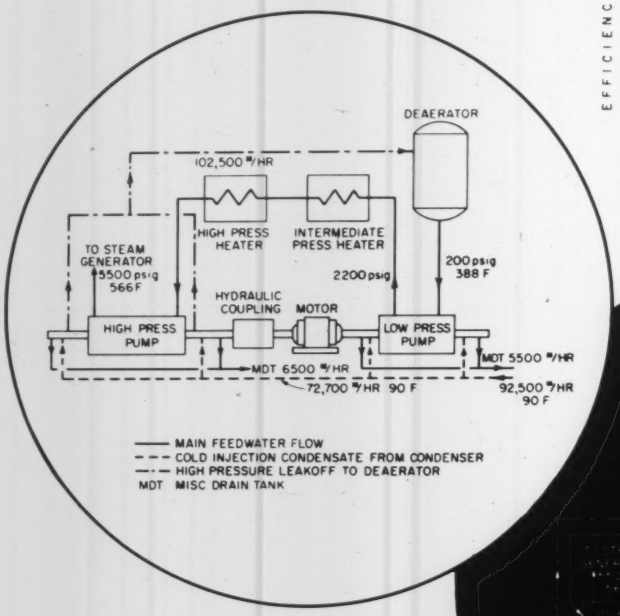

Fig. 2 *Above,* Feed-pump leakoff diagram showing the arrangement of floating Raphalloy shaft-seal bushings at the time of the heat-rate tests

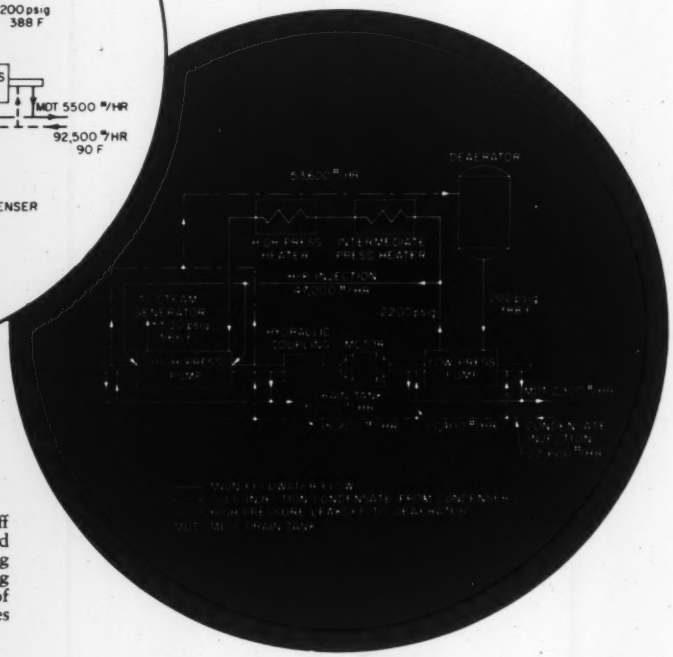

Fig. 3 *Right,* Feed-pump leakoff diagram after the changes had been made to the pump-sealing arrangement to eliminate bushing deformation and scoring of pump-shaft sleeves

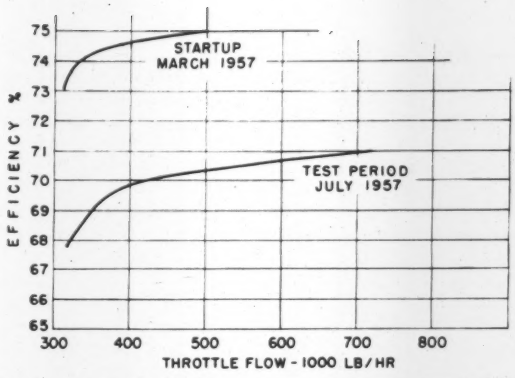

Fig. 4 Change in high-pressure-turbine internal efficiency based on throttle enthalpy and the pressure measured at the outlet of the No. 1 control valve. The use of this pressure accounts for the sharp fall-off in the efficiency curve at low loads because of the throttling in the control valves.

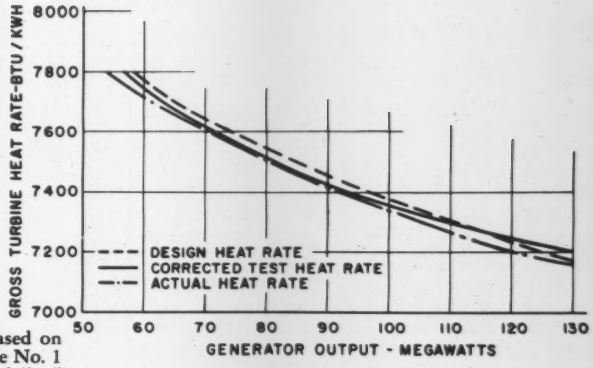

Fig. 5 Design and test gross turbine heat rates for the Philo supercritical-pressure unit 6

One major change in h-p pump design had already been made prior to plant tests by changing all of the impellers, and the manufacturer is presently submitting recommendations of other changes which will help to improve the pump efficiencies.

Subsequent to the July, 1957, tests, changes were made to the pump-sealing arrangement, Fig. 3. Due to flashing of the 550 F water which, in the first arrangement Fig. 2, was bled off to the deaerator, bushings were being damaged and a large amount—72,700 lb per hr—of cold-condensate injection was required to suppress flashing in so far as possible.

To virtually eliminate this flashing, a h-p injection was added receiving water directly from the discharge of the l-p pump at approximately 400 F with a pressure differential supplied by the pressure drop through the h-p and i-p heaters and associated piping. The only flashing possible is due to the temperature rise in the l-p pump. Cold-water injection could, therefore, be reduced to 15,200 lb per hr and, correspondingly, leakage to the deaerator could be reduced to 53,000 lb per hr. Each of these reductions has the effect of lowering thermodynamic losses substantially. This improved sealing configuration has been in operation for over a year.

A comprehensive program is now under way by the pump manufacturer to develop more effective shaft-seal designs, and an operating evaluation of these various design concepts is under way at Philo.

H-P-Turbine Efficiency

As soon as the unit was put in operation, enthalpy-drop efficiencies were taken across the h-p turbine, Fig. 4. These enthalpy-drop efficiencies were determined by accurately measuring the throttle and exhaust enthalpies, the bowl pressure, and the cooling-steam flow. Design curves were used to proportion the cooling steam at the points where it rejoins the main steam flow, and an expansion line was calculated to account for the mixing of the cooling steam at the second and fifth stages. A more complete series of enthalpy-drop efficiencies was taken in July, 1957, shown as the lower curve of Fig. 4. A third series of tests in February, 1958, showed the same results as the July, 1957, tests. The reduction in internal efficiency shown for July, 1957, raises the net heat rate about 35 Btu per kwhr. Subsequent internal examination of the h-p turbine has disclosed considerable deposits of copper oxide which may account for the rapid deterioration of efficiency between March and July of 1957. Presently, comprehensive research and development work is in progress to determine the source of this copper, the pickup and oxidation mechanisms, and satisfactory means for its elimination.

The h-p turbine rotor was steam cooled during the performance tests. The unit is now in service without rotor cooling, which should improve the net heat rate 23 Btu per kwhr.

Heat-Rate Tests

To definitively evaluate performance of the over-all cycle, carefully conducted full-scale heat-rate tests were run at the Philo 6 Unit in July, 1957, Fig. 5, using calibrated flow nozzles, thermocouples, and associated equipment. The test results are shown in two forms; the first, the "as-tested" data, in which corrections were made only to design steam pressure and temperature at the throttle, reheat temperatures, and back pressure; and the second, in which all equipment other than the turbine was corrected to "design" conditions. These tests show that although the efficiency of the h-p turbine was somewhat lower than expected, the efficiencies of the reheat and l-p sections were higher, so that the over-all turbine performance was almost identical with that predicted. Additional experience should give better understanding of the factors affecting this h-p-turbine efficiency. Higher efficiencies could then be maintained, particularly in the new larger-flow-volume machines which are presently under construction.

Auxiliary Power

Actual test and design auxiliary-power use of the Philo 6 Unit are shown in Fig. 6. The large deviation between design and actual test requirements is due in large part to the boiler-feed-pump power use as affected by efficiency, shaft sealing, and pumping of higher temperature feedwater. Other factors which have raised auxiliary use are continued high gas-recirculation rate and continuing use of pumps in the feedwater cleanup cycle.

Thermal Performance of the Philo Supercritical Unit

Over-All Performance

The net heat rate of the unit, based on heat-rate test data of July, 1957, is 8824 per kwhr at $1^1/_2$-in. back pressure, with steam conditions of 4500 psi, 1150 F, with reheat to 1050 F/1000 F. This heat rate includes auxiliary power of 12,900 kw. Fig. 7 shows heat-rate performance over the load range based on the July, 1957, test data. If the heat rate is corrected to predicted feed-pump leakages and efficiency, and predicted auxiliary-power requirements, it becomes 8661 Btu per kwhr at 1.2-in. back pressure (original design back pressure).

Since thermal performance of such a unit is judged by the running heat rate on a monthly basis, care was taken in the design of weighing and sampling equipment, as well as thermocouple locations, pressure taps, etc., to obtain a good measure of heat performance.

The actual operating heat rate of Unit 6 from November 1, 1957, through May 31, 1958, was 8886 Btu per kwhr. Eleven normal start-ups during this period increased the heat rate approximately 60 Btu per kwhr above what it otherwise would have been if the unit had operated continuously. In addition, during January, 1958, hot-restart tests were conducted so that there was an appreciable heat input to the unit without generation. Again in February, tests were carried out which involved firing the steam generators without kw output.

Future Work

A continuing series of programs is being carried on with the appropriate manufacturers to provide answers in the areas where unknown factors currently limit highest thermal performance. Studies with the steam-generator manufacturer will indicate whether or not it will be possible to reduce recirculating-gas fan speed and thereby reduce auxiliary-power requirements. The comprehensive shaft-seal test program now under way with the feed-pump manufacturer will develop better means for shaft sealing, and the projected changes in internal feed-pump design will improve efficiency. The largest effort is being devoted to a means of eliminating the copper-oxide deposits found in the h-p turbine.

Conclusions

The operation of the supercritical-pressure Philo No. 6 Unit has shown that, with careful design and operation, the higher thermal performance associated with higher pressures, temperatures, and double reheat can be achieved in actual practice. However, special precaution must be taken in the areas of water chemistry and mechanical design so that benefits from these high conditions are not tempered by additional cycle losses. This experience also indicates that, with these very high pressures, large-sized units are more attractive than small ones because the former require large flow volumes through which higher efficiencies of component equipment can more easily be obtained.

Experience from the design, construction, and operation of the Philo 6 Development Unit serves as a firm basis for the design, construction, and operation of the two 450,000-kw units currently under construction. These will operate at 3500 psi 1050 F with two stages of reheat to 1050 F, and although operating at steam conditions somewhat below those of Philo 6, will, because of their large size, have thermal performance equal to that of Philo 6.

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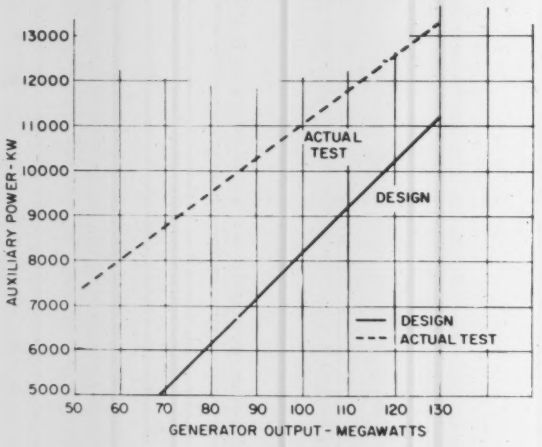

Fig. 6 Design and actual auxiliary power use of the Philo supercritical-pressure unit 6

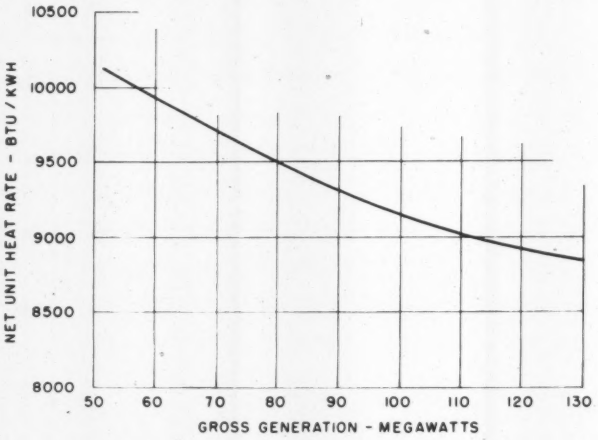

Fig. 7 Net heat rate at 1.5 in. Hg for the Philo supercritical-pressure unit 6

By Harry Hollingshaus

Vallecitos Atomic Laboratory,

General Electric Company,

Pleasanton, Calif.

"Spontaneous Fracture" OF BONES

Bone fractures which occur as a result of what is believed to be a small force being applied to the bone are one of the puzzling consequences of high levels of bone-deposited radioelements. Engineering methods used to solve problems in strength of materials have been applied in an attempt to correlate some of the mechanical properties of bone with the radiation received.

Since 1952, the University of Utah College of Medicine has operated a radiobiology laboratory whose primary mission has been to obtain experimental data on the effects of bone-seeking radioelements in order to establish better the maximum allowable level for humans. Experiments were made with a colony of approximately 400 beagle hounds. The radioelements used were plutonium, radium, mesothorium, radiothorium, and strontium.

One of the damaging consequences of high levels of bone-deposited radioelements is "spontaneous fracture," a term which is applied to bone fractures which occur when the force causing the fracture is believed to be small. Spontaneous fractures have been observed in radium-dial workers [1, 2],[1] and in the high-level-toxicity dogs of the radiobiology laboratory [3].

Why do these bones break?

The mechanical properties of bone present a problem in biomechanics whose solution requires many of the methods employed by engineers to solve similar problems in strength of materials.

The object of this study has been an attempt to correlate some of the mechanical properties of bone with radiation received. The results reported in this paper apply only to the shaft of long bones. Trabecular bone was not tested.

[1] Numbers in brackets designate References at end of paper.

Awarded "Old Guard Prize" from among twelve Regional Student Conference winners, at the Semi-Annual Meeting, Detroit, Mich., June 15–19, 1958, of The American Society of Mechanical Engineers. Condensed from paper, "Changes in the Mechanical Properties of Bone Due to Internally Deposited Radioelements."

Method

A bone in a living animal is normally subjected to tension, compression, torsion, and bending. The bone seldom, if ever, has a defined geometrical shape, and any approach to the problem becomes very complex. When conducting strength-of-materials tests it is usually desirable to have uniform sections, but because of the difficulties involved in making uniform samples from small bones it was decided to test an intact bone. The tibia of the beagle dog was selected because it was one of the only large bones of the dog that had not been used and destroyed in other tests. Also, the tibia was one of the most symmetrical of the large bones in the animal. The tibia was tested as a simple beam loaded at the center. A small hydraulic-testing machine was designed and constructed to perform the necessary tests, Fig. 1.

The hydraulic-testing machine used consisted of four main components: The hydraulic ram, frame, pressure gage, and fluid pump. These four components were mounted on a portable table top which allowed the unit to be moved anywhere in the laboratory. The bone was loaded by means of the hydraulic ram which was connected to the pump. A meter for measuring deflection was placed under the center of the bone. Simultaneous readings of both load and deflection were taken at approximately 20-lb intervals until the specimen had exceeded its elastic limit. The deflection meter was then removed and the bone was loaded until failure occurred. The force required to cause failure ranged from approximately 200 to 400 lb. The average time of loading from start to failure was about one minute.

The ultimate stress to which the bone was subjected is a function of the load applied, the distance between supports, the distance from the neutral axis to the outermost fiber of the cross section, and the area moment of inertia of the cross section.

The bending stress for a simple beam supported at each end and loaded at the center is given by the equation

$$S = \frac{M_c}{I} \tag{1}$$

where

S is the maximum stress
M is the maximum bending moment
c is the distance between the neutral axis and the outermost fiber
I is the area moment of inertia of the cross section

In a beam loaded as described, the maximum moment is at the center and in this case is given by

$$M = \frac{PL}{4}$$

where

P is the applied load
L is the distance between supports

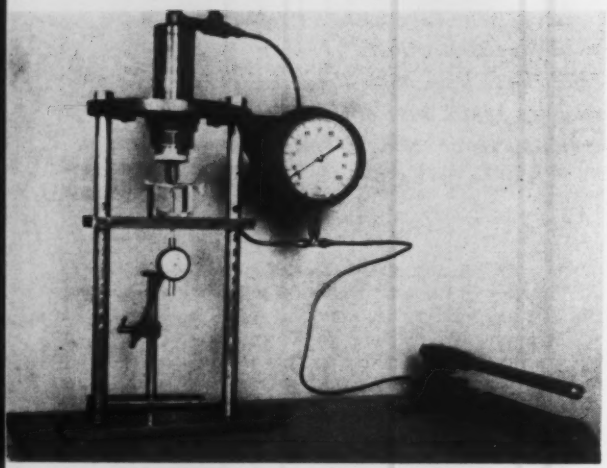

Fig. 1 The hydraulic testing machine consisted of four main components—the hydraulic ram, frame, pressure gage, and fluid pump—mounted on a portable table top which allowed the unit to be moved about the laboratory

To determine the moment of inertia, it was assumed that the cross section was that of a hollow ellipse, and dimensions corresponding to the major and minor axes, both outside and inside, were measured. Fig. 2 shows a sample cross section and the algebraic system of dimensioning which was used to denote major and minor axes.

The computed breaking stress, assuming the bone to be a simple beam, will be in some error because the area under consideration is not elliptic. However, for purposes of this test, comparative values were desired and the above-mentioned method of determining the area moment of inertia satisfies this requirement.

Deflection of the specimen was measured so that the modulus of elasticity could then be computed.

The change in deflection of the center of this beam Δy for any given change in load ΔP within the proportional limit is given by the equation

$$\Delta y = \frac{(\Delta P)L^3}{48EI}$$

Solving for the modulus of elasticity

$$E = \frac{(\Delta P)L^3}{(48(\Delta y)I} \tag{2}$$

There are certain assumptions and limitations to equations (1) and (2). Unless these conditions are complied with, the resulting bending stresses will not be correct. One limitation is that the stresses do not exceed the proportional limit. Another is that the cross section of the beam has a vertical axis of symmetry and the resultant of the load applied lies in this vertical plane. Clearly, in this application these conditions were not precisely adhered to and as a result the computed breaking stresses are not exact. However, because comparative values were desired and because all bones tested were very similar in shape, and were tested in exactly the same manner, it is felt that the results obtained using the flexure formula are entirely satisfactory.

All stresses recorded in this paper are maximum stresses at the outermost fiber from the neutral axis. Their computation was made possible by assuming the material was homogeneous.

Results

Effect of Age. In order to correlate the results of this test, it was first necessary to establish data from control animals. Normal tibiae were taken from uninjected animals or animals whose skeletal dose was so low that the effects on bone strength were considered to be negligible. The upper limit of average skeletal dose for animals used as controls was 200 rads.[2] These values are small compared to the maximum dose of 14,000 rads given a test animal. Low-dose animals were used to establish control data because there were not enough tibiae available from uninjected beagles.

To determine the effect of age on the breaking stress on control animals, the breaking stress was plotted against the age of the dog at death as shown in Fig. 3. Breaking stress increases from an average value of approximately 28,500 psi at 15 months of age to 34,200 psi at 75 months. These values compare favorably with those obtained by other authors. For normal rat femurs tested in bending [4], the average breaking stress was 35,000 psi. For a group of sheep bones which were tested in bending [5], the values of breaking stress ranged from 16,700 to 37,400 psi with an average value of 27,300 psi. This comparison is made only to verify the general magnitude of the breaking stresses established in this paper.

The modulus of elasticity for normal tibiae was plotted against age at death as shown in Fig. 4. The graph shows that there is a definite increase of the modulus of elasticity as the age of the dog increases. This means that normal bone becomes more rigid or stiff with age.

An important observation pertaining to Figs. 3 and 4 is that the oldest tibiae tested were taken from dogs

[2] A rad is defined as the absorption from ionizing radiation of 100 ergs of energy per gram of tissue.

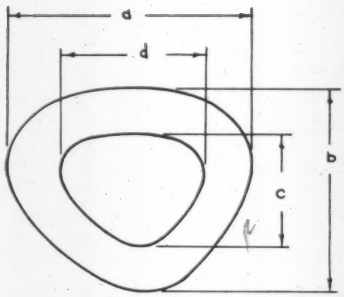

Fig. 2 A sample cross section and the algebraic system of dimensioning which was used to denote major and minor axes

DOG	Age at death, days	Injected dose, c/kg	Burden time, days	Cumulative dose, rads	Measured breaking stress, psi-	Modulus of elasticity, millions of psi[2]	Number of spontaneous fractures observed in dog
M1P5	1736	2.67	1324	5350	25,700	1.30	4
F6P5	1601	2.57	1194	4625	38,000	....	7
T8P5	1390	2.67	863	3600	25,600	1.08	8
T7P5	1252	2.68	777	3280	28,000	1.42	5
T3P5	1552	3.22	610	3124	34,200	1.45	0
F2P4	2123	1.03	1556	2380	29,500	1.29	0
M1P4	2166	0.823	1724	2100	34,200	1.48	1
T6P5	933	2.73	406	1830	35,600	1.67	0
T5P5	874	2.69	400	1780	26,800	1.46	2
F7P4	1683	0.963	1198	1755	28,000	....	0
F7P4	1683	0.963	1198	1755	31,700	1.38	0
M3P4	1673	0.929	1198	1670	31,000	1.04	5
M3P4	1673	0.929	1198	1670	25,600	....	5
F5P4	1895	0.872	1245	1655	38,500	1.59	0
M4P4	1633	0.974	1066	1610	31,600	1.29	0
M4P4	1633	0.974	1066	1610	32,600	1.37	0
M3P3	2089	0.291	1604	698	32,000	1.78	1
M1P3	1888	0.261	1476	625	34,500	1.82	0
M1P3	1888	0.261	1476	625	30,400	1.37	0
T11P5	544	2.76	28	166	35,800	1.44	0
T11P5	544	2.76	28	166	26,300	1.29	0
T12P5	515	2.74	28	164	28,700	1.36	0
T12P5	515	2.74	28	164	30,800	1.33	0
T9P5	566	2.80	15	70	31,200	1.24	0
T9P5	566	2.80	15	70	27,800	1.08	0
T10P5	549	2.74	15	68	23,800	0.85	0
T10P5	549	2.74	15	68	29,000	1.35	0
F10P1.7	1206	0.0495	467	38	31,800	....	0
F10P1.7	1206	0.0495	467	38	28,300	1.52	0
T13P5	590	3.16	3	15	27,000	1.21	0
T13P5	590	3.16	3	15	23,400	0.98	0
M2R5	1850	10.8	1385	14,900	(tumor)	....	8
M5R5	1678	10.1	1217	12,600	14,600	0.86	16
M5R5	1678	10.1	1217	12,600	21,500	....	16
M1R5	1381	10.5	908	10,300	21,800	....	2
F8R5	1442	9.68	968	9920	27,800	1.30	17
M10R5	1352	10.2	820	9380	17,200	....	18
M10R5	1352	10.2	820	9380	22,100	1.28	18
T2R5	2287	4.39	1368	6950	23,700	1.09	0
T12R5	622	9.72	225	2910	29,400	1.30	0
T13R5	586	9.76	188	2440	25,800	1.54	0
F3R4	874	3.191	490	1880	28,800	1.27	0
T9R5	2334	1.94	58	165	36,100	1.89	0
T9R5	2334	1.94	58	165	37,000	1.51	0
T8R5	348	1.92	58	163	31,500	1.27	0
T16R5	616	9.70	12	163	32,500	1.11	0
T5R5	127	11.7	1	14	23,600	0.78	0
T6R5	127	11.4	1	14	25,800	1.33	0
M2T4	1291	0.916	833	6140	9,600[a]	....	33
M4T4	1399	0.835	793	5430	21,800	....	4
M4T4	1399	0.835	793	5430	26,900	1.37	4
M2T3	1317	0.301	859	2090	31,500	1.58	0
T2T5	578	2.56	77	2080	35,600	1.96	0
M4T3	1407	0.285	801	1880	38,800	2.08	0
M4T3	1407	0.285	801	1880	29,600	1.49	0
F3T3	1018	0.272	547	1510	25,000	1.24	0
M1T2	1773	0.097	1282	844	29,500	1.47	0
M4T2	631	0.090	78	74	27,600	1.09	0
M4T2	631	0.090	78	74	29,700	1.10	0
T3M5	1275	10.1	700	9400	31,400	1.52	12
M3M5	1268	9.93	689	8930	24,350	....	12
M3M5	1268	9.93	689	8930	27,600	1.24	12
F2M2	1482	0.355	965	515	26,800	1.00	0
M3M2	1194	0.342	618	267	33,200	1.41	0
MAC3	1451	....	....	....	34,000	....	0
MAC3	1451	....	....	....	33,000	1.34	0
MAC36	1971	....	....	....	31,100	....	0
MAC35	529	....	....	....	31,000	1.28	0
MAC35	529	....	....	....	29,000	1.24	0
FAC10	2605	....	....	....	30,000	1.50	0

[a] M2T4 had fractured and healed.

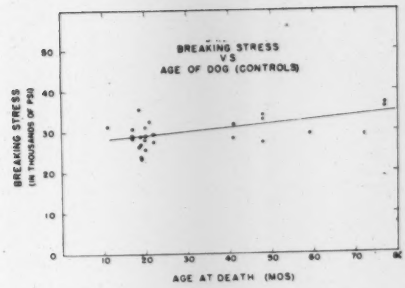

Fig. 3

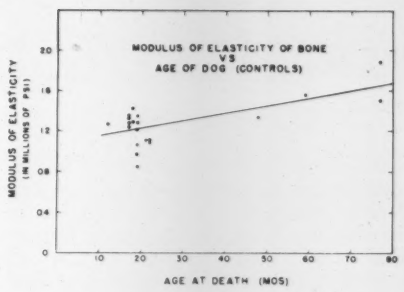

Fig. 4

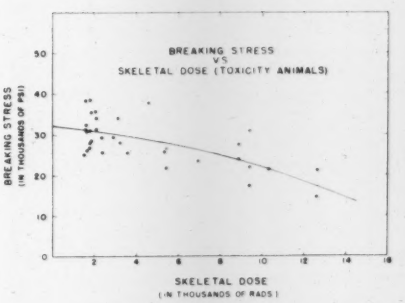

Fig. 5

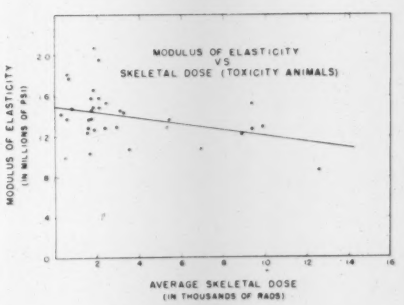
MODULUS OF ELASTICITY
VS
SKELETAL DOSE (TOXICITY ANIMALS)
MODULUS OF ELASTICITY (IN MILLIONS OF PSI)
AVERAGE SKELETAL DOSE (IN THOUSANDS OF RADS)

Fig. 6

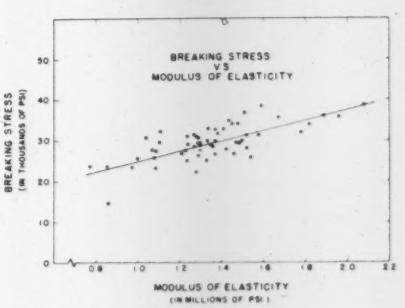

Fig. 7

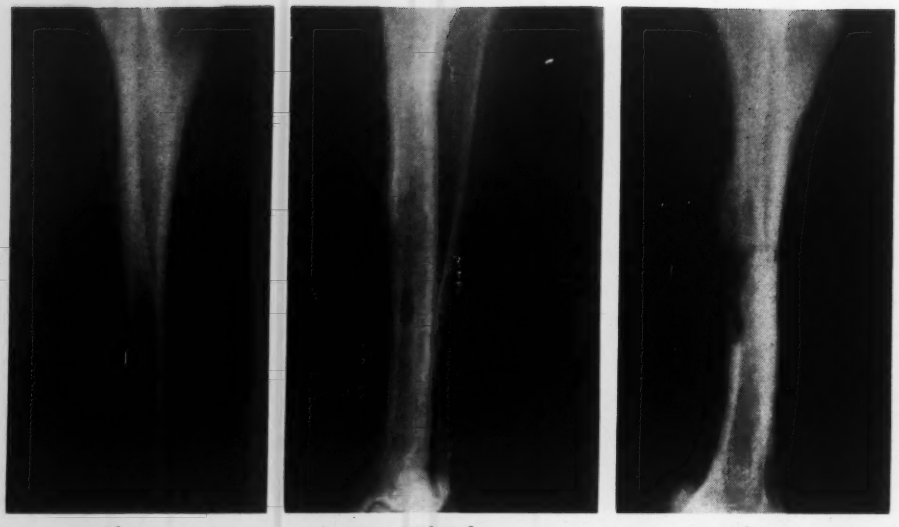

Photo a *Photo b* *Photo c*

Fig. 8 Three x-ray photographs of a tibia from dog M2T4, taken before autopsy. Photo (*a*) was taken before injection and appears to be normal in all respects; (*b*) was the last x ray taken before a fracture of the tibia was observed; some of the material has been removed by resorption, leaving cavities; (*c*) was taken one month after (*b*) and showed that the fracture occurred at the point where resorption was greatest.

which were between 80 and 90 months old at death. Consequently, there are no control data for animals over this age, and what happens to the breaking stress as well as the modulus of elasticity of "senile" bone was not investigated.

Effect of Irradiation. Plotting breaking stress against average skeletal dose in rads resulted in Fig. 5. Average skeletal dose was calculated from the measured skeletal retention of the injected isotopes and their daughters in the test beagles [6]. No correction has been made for age effects. Because most of the animals in the toxicity group were between 40 and 80 months at death, the effect of age on the breaking stress would possibly amount to some value between 2000 and 3000 psi, which would not greatly affect Fig. 5. The graph shows a definite decrease in breaking stress of the tibia as the radiation dose to the animal increases. It should be observed that the tibia from a high-level animal, whose average skeletal dose was 12,600 rads, has about half the strength of a normal tibia.

Modulus of elasticity is plotted versus average skeletal dose in Fig. 6. The modulus of elasticity decreases as skeletal radiation increases.

Breaking Stress Versus Modulus of Elasticity. Breaking stress versus modulus of elasticity for all bone tested is plotted in Fig. 7, in which both the breaking stress and the modulus of elasticity were determined. No attempt has been made to separate toxic animals from control animals. The purpose of this graph is to show how breaking stress increases as the modulus of elasticity increases. This graph furnishes a confirmation of work done by Toajari [7] and also Evans and Lebow [8] on nonirradiated bone.

Observed Fractures in Colony Beagles. The question as to why irradiated bones break has still not been answered by this study. Even though a noted decrease in strength was observed, it does not explain the spontaneous fracture.

All long-bone fractures occurred in dogs whose average skeletal radiation dose was over 3600 rads. A possible explanation for the fracture in long bones may be shown in Figs. 8 and 9.

Three x-ray photographs of a tibia from dog M2T4 are shown in Fig. 8. These x-rays were all taken before autopsy. Fig. 8 (*a*) was taken before injection and appears to be normal in all respects. Fig. 8(*b*) was the last x ray taken before a fracture of the tibia was observed. The center portion of the shaft shows that the bone is not homogeneous in the same sense that it was before injection. The bone has undergone a change wherein some of the bone material has been removed as a result of the exposure of the animal to radiation. This phenomenon, which results in cavities being left throughout the material, is called resorption and the remaining voids in the material are defined as resorption cavities. Exactly how these cavities occur and what causes them has not been determined. Fig. 8(*b*) shows excessive resorption in the shaft of the bone. Fig. 8(*c*) was taken

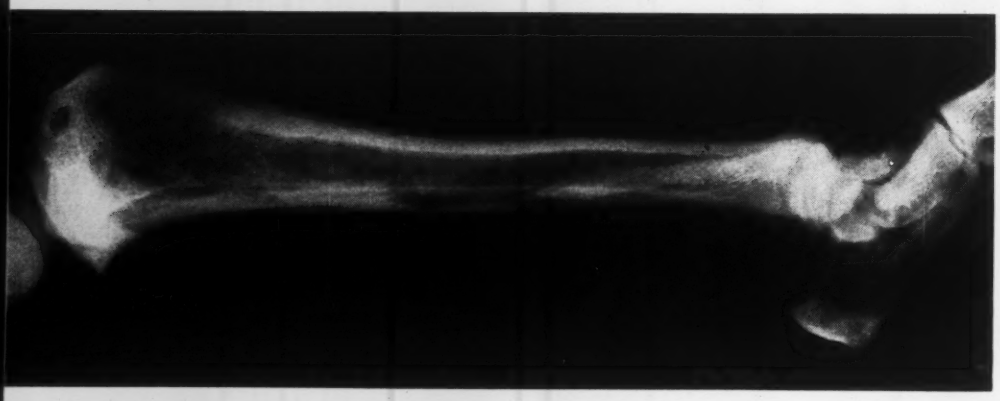

Fig. 9 X-ray photograph of a tibia from dog M5R5 taken shortly before the death of the animal which had received a cumulative skeletal dose of 12,600 rads. The center portion of the shaft has been greatly resorbed and when tested failed at a breaking stress of 14,600 psi.

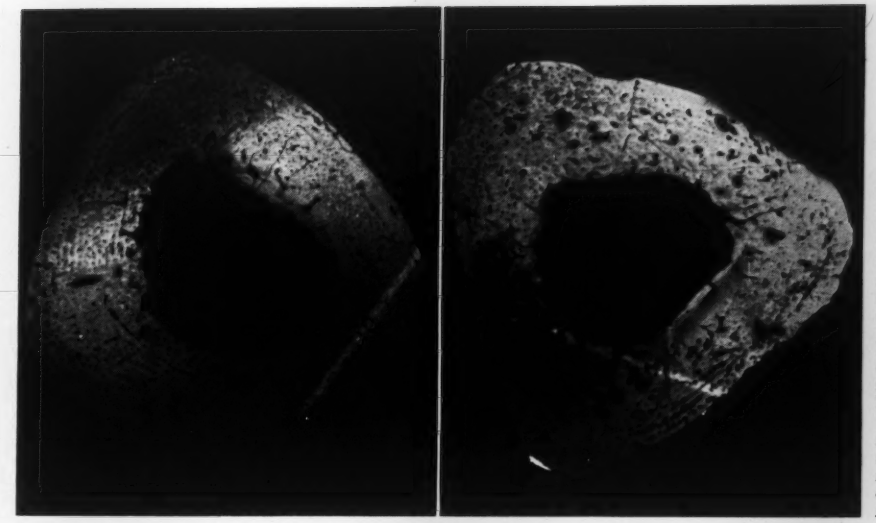

Fig. 10 *Left,* x ray of cross-sectional area from the tibia of dog T9R5 who carried his burden only 58 days and who received an average skeletal dose of 165 rads. The bone appears to be normal, and breaking stress was 37,000 psi.

Fig. 11 *Right,* x ray of cross-sectional area from the tibia of dog M1R5 who carried his burden 908 days and received an average skeletal dose of 10,300 rads. Large resorption cavities are present as a result of the radiation.

one month after Fig. 8(*b*). The fracture occurred at the point where resorption seemed greatest. Probably resorption was the major cause of fracture.

An x-ray photograph of a tibia from dog M5R5 is shown in Fig. 9. This x ray was taken shortly before the death of the animal. It had received a cumulative skeletal dose of 12,600 rads. The center portion of the shaft has been greatly resorbed and when tested failed at a breaking stress of 14,600 psi.

X-ray photographs of two cross-sectional areas of tibiae are shown in Figs. 10 and 11. Fig. 10 is an x ray from the tibia of dog T9R5 who carried his burden only 58 days and received an average skeletal dose of 165 rads. This bone appears to be normal. The breaking stress was 37,000 psi. Fig. 11 is from the tibia of dog M1R5 who carried his burden 908 days and received an average skeletal dose of 10,300 rads. Large resorption cavities are present as a result of the radiation. The bone was loaded so that the greatest tension appeared at the top center section. The breaking stress of this bone was 21,800 psi, or only 59 per cent of that observed in the near normal bone from T9R5.

Speculations on Decrease in Bone Strength

Assume that on a microscopic level the modulus of elasticity of bone is unaffected by radiation. (There are no data to prove or disprove this assumption.) Solving equation (2) for moment of inertia

$$I = \frac{(\Delta P)L^3}{48(\Delta y)E_c}$$

If the modulus of elasticity for nonradiated dogs, Fig. 4, is used, then a theoretical moment of inertia can be computed. This theoretical moment of inertia is observed to be less than the measured moment of inertia based on inside and outside dimensions of the bone cross section in irradiated bone. Substituting this new value of I into equation (1) for stress, a new breaking stress may be computed which, in almost all cases of high-level-toxicity dogs, is considerably greater than the value which was computed, making no allowance for the resorption cavities. This method of computing a new ultimate strength tends to increase the breaking stresses such that there is no apparent difference between the breaking stress in the nonresorbed bone of a high-toxicity animal and that of a normal or control animal.

Conclusion

Both the breaking stress and the modulus of elasticity increase with age within the limits tested, in the tibiae of normal uninjected dogs. In radiated animals, the breaking stress and modulus of elasticity decrease as the skeletal radiation dose increases. Part of this decrease in strength is due to radiation-induced resorption cavities, but the fraction of weakening due to this one factor alone has not been established. Further study of irradiated bone on a more refined level would appear to be justified.

Acknowledgments

The successful completion of these studies was made possible by the co-operation of many individuals connected with the Radiobiology Laboratory of the University of Utah College of Medicine. Special appreciation is extended to Dr. C. W. Mays and W. S. S. Jee, who originally suggested this study and gave constant advice, encouragement, and assistance throughout the experiment. Appreciation is also expressed to D. A. Taysum, B. W. Glad, and L. W. Blake for their helpful assistance during all stages of the experiment.

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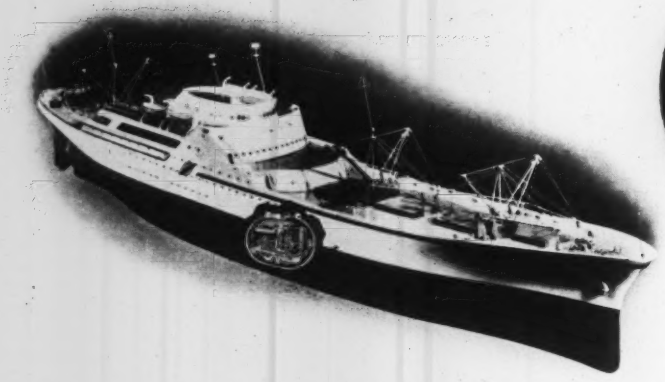
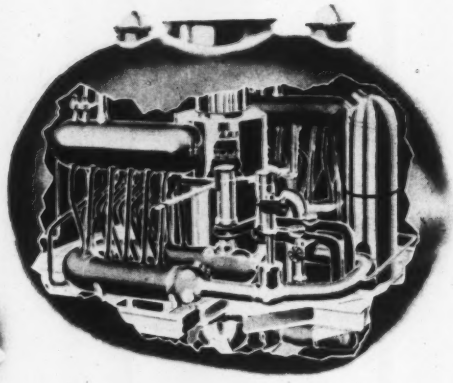
Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD





The reactor for the *NS Savannah* will be amidships at the D-deck level. The ultimate in safety, water shielding in the containment vessel will prevent disaster if all other precautions fail.

NS Savannah on Schedule

THE *NS Savannah* is adhering closely to the rigid schedule set for her construction. B & W was awarded the prime contract for design, development, and fabrication of the power plant on April 4, 1957, and the ship is to be launched this summer. This is something of a record for a contract requiring so much development.

The De Laval Steam Turbine Company, Trenton, N. J., delivered the propulsion and auxiliary turbogenerator components early in March to the New York Shipbuilding Corporation, Camden, N. J. These will be installed in the hull of the 587-ft-long 78-ft-beam nuclear-powered vessel. Two heat-exchanging steam generators have also been shipped from The Babcock & Wilcox boiler plant in Barberton, Ohio, and the 100-ton pressure vessel will be shipped this month.

The pressurized-water reactor is now being installed in the containment vessel aboard the 60-passenger 30-stateroom ship that will also carry 10,000 tons of cargo in seven holds and have a crew of 120. The 21,840-ton-displacement ship, designed by naval architects George Sharp, Inc., will cruise at 20 knots and have an estimated range of 350,000 miles, or $3\frac{1}{2}$ years of continuous operation, on one loading of nuclear fuel.

The design is conservative in every respect, particularly with regard to safety. Each boiler primary pump is capable of carrying 75 or 80 per cent of the flow; there is extra shielding; the reactor is located where it would be least likely to suffer collision damage; and a 168-point annunciator system will indicate any irregularity.

If all other safety precautions fail and the reactor melts down in a transient, the water shielding in the containment vessel will have sufficient cooling capacity to prevent penetration of that final shield. Although oversafe to an expensive degree, any possibility of disaster and unfavorable public reaction has been avoided.

The machinery supplied by De Laval as subcontractor comprises the main turbines, main reduction gear, turbine generators, main and auxiliary condensers, feedwater heaters, and feedwater pumps. These are tied together in a 242,200-lb-per-hr normal-steam-consumption system that can deliver 261,460 lb maximum and supply 20,000 to 22,000 shp.

The propulsion unit is of the cross-compound condensing-turbine type with moisture separators in the crossover, since steam conditions are only 470 psia, 347 F for normal power. While these would be low steam conditions for conventional fuel, the severe metallurgical requirements for this operation would have been impossible a few years ago.

The "supposedly" dry saturated steam requires "moisture catchers" over the blades of both the h-p and l-p turbines. The moisture collected is returned to the condensate system. Stellite facing on the blades of the l-p turbine affords erosion protection.

According to C. A. Jurgensen, vice-president in charge of manufacturing at De Laval, the equipment ran well from the start of testing, and indicated "a very fine running unit" that will outlast the ship.

De Laval-Stoeckicht planetary gears are used in place of the normal parallel-shaft reducers to achieve a 60 to 70 per cent saving in space and about a 70 per cent saving in weight for the gears alone. There is also a 2-ft-wide space saving for the length of the assembly. The main gears are 176-in-diam and approximately 4-ft-wide double-helical and fine-toothed. The 580 teeth machined in a controlled-temperature environment are true within

0.0005 in. and spaced with a tolerance of only 0.0002 in.

The 74-mw UO_2-fueled pressurized-water reactor has an 8,000,000-lb-per-hr coolant flow and is designed for 2000 psia with an average coolant temperature of 508 F. In addition to scram provision, servo controls on 9 of the 21 cruciform control rods permit reduction to 20 per cent of full power for hotel load when the ship is in port.

The reactor system is located in a special 67.5-ft compartment just ahead of the machinery space—about amidships at the D-deck level. The major portion of the reactor system, including the reactor itself, the primary coolant loops, the pressurizer, the steam generators, the primary circulating pumps, most of the auxiliary systems, and an air-conditioning system will be housed in a cylindrical containment vessel 35 ft in diam by 50.5 ft long lying fore-and-aft in the center of this compartment. Only those auxiliary systems which may require special maintenance are placed outside the containment vessel—the primary water demineralizers and filters, the charge pumps, the drain tanks, and gaseous-waste-collection system, among others.

An experimental core, simulating the one to be installed in the *Savannah*, has been operating at B & W's nuclear laboratory, Lynchburg, Va., since February, 1958. Complete confirmation of analytical calculations made in the process of designing the ship's propulsion plant will be sought in tests.

The vessel is a joint venture of the U. S. Atomic Energy Commission and the Maritime Administration.

Incidentally, this is an all-ASME project as far as De Laval is concerned. President James P. Stewart; vice-president in charge of engineering, Harry Engvall; chief engineer, turbines, J. S. Haverstick; and vice-president Jurgensen already mentioned, are all Mem. ASME. V. S. Wagner, turbine engineer, controls, and F. A. Thoma, assistant chief engineer, gears, are Assoc. Mem. ASME.

AEC Report

The 25th Semi-Annual Report of the Atomic Energy Commission, issued recently, has been enlarged to provide a handy reference on the entire Atomic Energy program. The 386-page report, available from the Superintendent of Documents for $1.25, is divided into three parts.

The first part is a review of industrial atomic progress during 1958, indicating the status of individual power reactors, outlining the supporting programs, progress on radioisotope development, international industrial progress, and biomedical assistance to the atomic industry.

Part two is a summary report on the Geneva Conference. Abstracts of the U. S. papers presented at the Conference are included in an appendix and there is a report on the scientific and technical exhibition.

The major activities in selected atomic-energy programs during July-December, 1958, are in part three.

Tabular information on staff, committee, and U. S. Geneva-delegation personnel, major research and development installations, Commission-owned patents, AEC regulations, and various statistical presentations are included in the appendixes.

Underground Nuclear Explosions

The Bureau of Mines has asked 70 firms and individuals in the petroleum and chemical industries for their attitudes toward bearing half of the expense of a joint $\$2^1/_2$-million underground nuclear explosives experiment with the Atomic Energy Commission. A small thermal-recovery experiment would simulate and precede a larger one to study the recovery of shale oil by an in-situ retorting process in the broken oil shale.

Oil-shale deposits in Colorado, Utah, and Wyoming are believed to be the largest untapped oil reserve in this continent, if not in the world. Other possibilities for oil recovery are large deposits of tar sands whose oil viscosity precludes the use of conventional techniques, and the recovery of secondary oil from fields too depleted for conventional techniques.

Competitive Ship Reactor

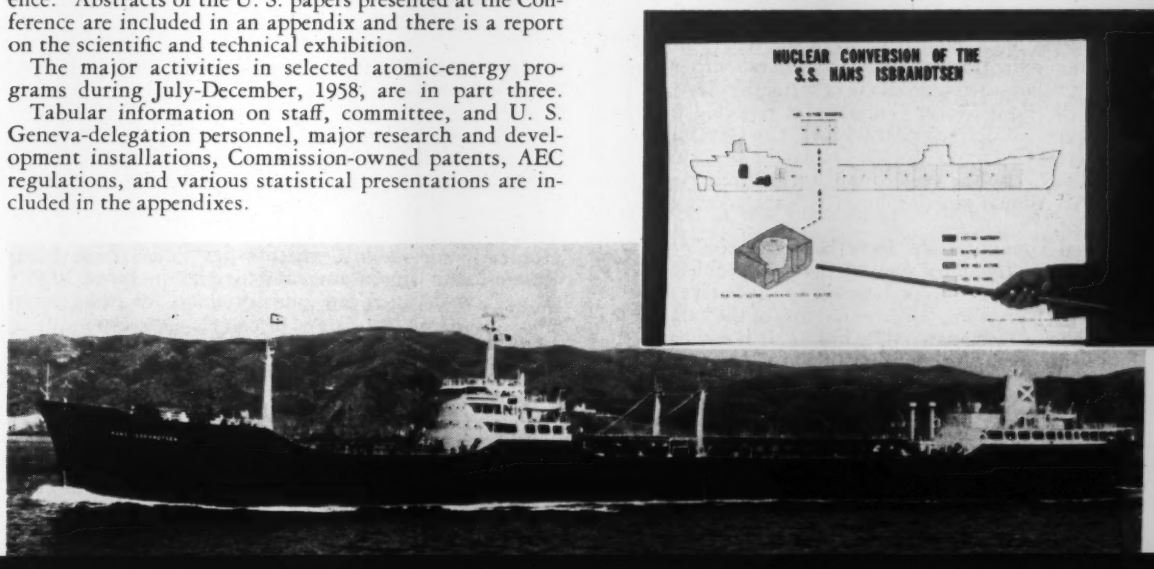
A graphite-moderated helium-cooled reactor that would use 950-F gas to generate superheated steam has been proposed for merchant-ship propulsion. It would be built by a special industry group comprised of Ford Instrument Company, Division of Sperry Rand Corporation; Maryland Shipbuilding and Drydock Company; and Isbrandtsen Company, Inc. Steam conditions would be fully adaptable to use with conventional steam equipment.

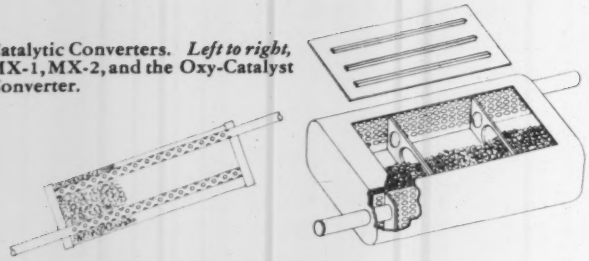
The advanced-type reactor which would be economically competitive with conventional fuels would be installed and tested in a cargo-tank section of a vessel. After testing, the section would be substituted for an existing section of the *SS Hans Isbrandtsen*, a 32,791-ton tanker launched in July, 1958. Thus a single reactor would serve both test and operational purposes.

Gas cooling would be unaffected by the roll and pitch of the vessel, corrosion problems associated with water-type reactors would be absent, and the steam would not be radioactive.

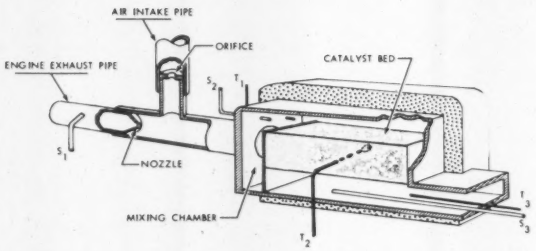
Ford Instrument would develop and construct the nuclear portion of the propulsion plant; Maryland Shipbuilding would conduct the marine-engineering and naval-architectural phases; and Isbrandtsen would provide vessel, crew, and operational administration. Legislation would be sought to permit AEC and Maritime Administration support.

In the *Isbrandtsen* proposal, a new hull section containing a pretested reactor would be substituted for an existing section of the ship





Catalytic Converters. *Left to right,* MX-1, MX-2, and the Oxy-Catalyst Converter.



Auto Exhaust and Smog

"It is generally conceded that automobile exhaust is the major uncontrolled source of smog in Southern California," according to the foreword of the Air Pollution Foundation's report on "Automobile Exhaust and Smog Formation" published over a year ago. The principal factor has been identified as "a reaction between organic matter and nitrogen oxides in the presence of sunlight."

For several years, the Automobile Manufacturer's Association has had a program to reduce the emission of hydrocarbons and oxides of nitrogen from automobile exhausts. Member companies have also been working on the problem.

Since most methods of treatment prior to combustion are impractical for one reason or another, most research has been concentrated on exhaust treatment, and a session of the recent Annual Meeting of the Society of Automotive Engineers was devoted to the subject.

Catalytic Oxidation

G. J. Nebel and R. W. Bishop of General Motors Research Laboratories reported on an evaluation of the Houdry method for catalytic oxidation of automobile-exhaust gases. Although a major engineering development program will be needed to solve the many difficult problems before catalytic oxidation can become commercially acceptable, the method is technically feasible even when commercial leaded gasoline is used. A 75 per cent reduction in hydrocarbon emission after warm-up seems reasonable, and carbon monoxide is oxidized to about the same degree. With a combination of the Houdry catalyst and a special carburetor to remove oxides of nitrogen, it seems possible after warm-up to remove: 90 per cent of the hydrocarbons, 75 per cent of the carbon monoxide, and 90 per cent of the oxides of nitrogen.

Vanadium Pentoxide

Vanadium pentoxide appeared to be the most promising catalyst in an evaluation from the standpoint of hydrocarbon-reduction efficiency and resistance to poisoning by the decomposition products of tetraethyl lead, according to the Ford Motor Company as reported in a 1957 SAE paper. A design program for "The Development of a Catalytic Converter for the Oxidation of Exhaust Hydrocarbons," by the same company, was reported at the 1959 SAE Annual Meeting by R. T. VanDerveer and J. M. Chandler.

Several configurations have been experimented with and solutions found for such mechanical problems as: (*a*) The introduction of secondary air, (*b*) excessive exhaust-system back pressure, (*c*) attrition loss of the catalyst material, and (*d*) exhaust-system noise. It is estimated that an over-all operating efficiency of 60 to 73 per cent can be achieved over the AMA traffic cycle, based on hydrocarbon analysis with a hexane-sensitized infrared detector. Idle efficiency was 88 per cent, deceleration 91, acceleration 68, and cruise 74. These efficiencies remain relatively unchanged for at least 10,000 miles. In order to achieve a commercially acceptable catalytic-converter system, the quantity of catalyst required must be optimized between minimum warm-up time, maximum durability, and converter size. Means to prevent unpleasant odors and for bypassing the converter under continuous heavy-duty conditions should also be evaluated.

Effects With Leaded Fuel

W. A. Cannon and C. E. Welling, also of the Ford Motor Company, reported on the effects with leaded fuel in "The Application of Vanadia-Alumina Catalysts for the Oxidation of Exhaust Hydrocarbons." Thermal stability of aluminas and the deposition of lead in fixed beds were treated in considerable detail since they may have extensive application to other catalyst systems and exhaust-treatment devices. Vanadium pentoxide when properly dispersed on moderate to high area gamma-type alumina was shown to have catalytic activity for vapor-phase destruction of gasoline-range hydrocarbons at temperatures and space velocities which appear reasonable for automotive application.

Such catalysts are particularly effective for destructive oxidation of olefins, even at low operating temperatures. Carbon monoxide was oxidized above 800 F at space velocities[1] from 3300 to 7400 per hr. Silica-stabilized vanadia-alumina catalysts containing up to 10 wt per cent V_2O_5 have sufficient thermal stability to permit their operation at 1000 to 1100 F for several hundred hr without excessive surface-area loss, with toleration of short periods at 1300 to 1400 F. Thermal stability of unstabilized gamma-type aluminas containing 10 wt per cent V_2O_5 may be marginal for automotive application.

Although a slow cumulative and nonuniform deactivation of the catalyst is produced by lead-vanadium compounds, activity remains reasonable to 10,000 miles.

Use of an Afterburner

Another approach which would overcome any difficulty with lead poisoning of catalysts would be the use of an afterburner to complete the oxidation of the fuel passed on by the engine. Stuart L. Ridgeway, of Thompson Ramo Wooldridge Inc., presented a paper on homogeneous reaction kinetics and the afterburner problem. Automobile exhaust gas differs from other economically significant combustibles in being highly diluted with nitrogen and products of the initial

[1] Number of volumes of fluid per hr which pass through the volume occupied by the catalyst bed.

combustion and is frequently at an initial temperature at which combustion reactions proceed slowly. In most typical combustion phenomena there are temperature rises of at least 2500 F, whereas in the automobile afterburner there would be a temperature difference of only a few hundred degrees between the burnt and unburnt gas, and thermal conduction is negligible.

To determine the operating temperature and volume for a reactor using a countercurrent heat exchanger operating on the heat energy of the fully burnt exhaust gas, a synthetic exhaust gas was made from N_2, CO, water vapor, and raw gasoline. This mixture was ignited and used to heat up a system composed of a homogeneous reactor and heat exchanger to a temperature where stable operation on an equivalent of cruise exhaust took place.

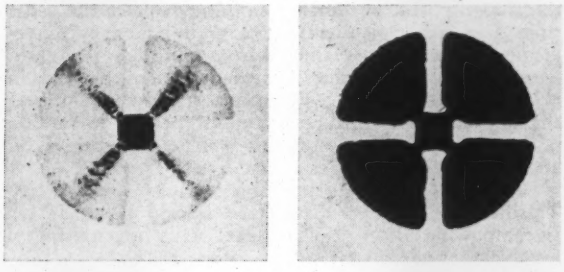
The minimum operating temperature was in the vicinity of 1450 F, but 1550 F was preferable for satisfactory stability. Once a reaction was satisfactorily established, a final hydrocarbon concentration of 25 ppm on cruise and acceleration and about 70 ppm on deceleration was normal performance for the Mark III afterburner that was used. This had a combustion chamber volume of 0.1 cu ft and was tested on a 1955 Chevrolet with a 265-cu-in engine. Other details were developed on residence time, concentration range, and the amount of air needed.

Maintenance and the Exhaust

The relation of maintenance to the automobile exhaust was discussed by W. S. Fagley, M. V. Sink, and C. M. Heinen of the Chrysler Corporation. Both field and laboratory data were obtained on the substantial reduction in hydrocarbon emission and attendant fuel savings that is possible through regular checks of the compression, spark plugs, distributor, manifold, timing, and carburetor. The progress to date indicates that reduction of hydrocarbon and carbon-monoxide emissions of the order of 60 per cent is possible by regular maintenance.

These five papers supplement 13 previous reports to the SAE during the past 18 months on the basic research and instrumentation phases of the industry program.

Filter papers from the exhaust-gas analyzer quickly identify the well-tuned car and the one requiring maintenance by the amount of particulate matter



Ground-Support Vehicles

More than 100 compact, multipurpose power vehicles which consist of a gas-turbine compressor mounted on a panel truck or AiResearch-built trailer, have been ordered from The Garrett Corporation's AiResearch Manufacturing Division of Los Angeles, Calif., by five different airlines. The vehicles perform ground-support functions for the Boeing 707 and Lockheed Electra.

They provide an independent source of pneumatic power for starting-jet and propjet commercial airliners. Compressed air is also furnished for ground operation of turbine-driven vapor or air-cycle refrigeration equipment for comfort of passengers awaiting take-off; ice and snow removal; and other low-pressure pneumatic jobs.

A second configuration includes a gas-turbine compressor combined with a power unit. It provides pneumatic power plus shaft power to drive a 60 to 80-kva alternator for checking out radio, radar, and hydraulic equipment, and operating electrical vapor-cycle cooling or heating.

The gas-turbine compressor operates at − 65 F to 130 F. Recommended service life between overhauls is 1000 hr or 3000 starts, whichever occurs first.

1965 Gas-Turbine Auto

Gas-turbine cars are a possibility by 1965, according to University of Michigan engineer, Frank L. Schwartz, Mem. ASME, quoted from the ASME 1958 Gas Turbine Progress Report.

The technical problems of building automotive gas turbines have been solved, Professor Schwartz states, according to an item in the *Industrial Research Newsletter* of Armour Research Foundation. The major problems remaining are chassis and body designs and reduction of turbine manufacturing costs.

The gas-turbine automobile would have a number of advantages over the internal-combustion piston-engine car. Kerosene or fuel oil would be the economical fuels burnt in its 200-hp engine. Turbine wheels could have a life of 100,000 miles and be replaced with less difficulty than piston rings.

Expanded Steel Capacity

Steelmaking capacity increased during the year by nearly seven million tons to a record 147,633,670 tons.

A substantial amount of the increase was attributable to the installation of new oxygen furnaces in several steel plants, according to *Steel Facts*, published by the American Iron and Steel Institute. The annual capacity of oxygen furnaces is now 4,033,160 tons. Combined capacity of open-hearth furnaces is 126.5 million tons, and of electric furnaces about 13.5 million tons. Bessemer capacity declined to 3.6 million tons.

Basic-Oxygen Steelmaking

In completion of a $214-million expansion program, Kaiser Steel Corporation has begun production at Fontana, Calif., with three oxygen furnaces having an annual capacity of 1,440,000 tons. A jet of high-purity oxygen is directed over the surface of the molten metal in these furnaces, resulting in an immediate reaction which builds the temperature of the metal up to 3000 F and refines the charge into high-quality steel. Refining time for the process is less than 30 minutes. This is the largest installation of this type, and the third U. S. facility.

Kaiser's expansion program has virtually doubled annual ingot capacity from 1,536,000 to 2,933,000 tons. In addition to the basic-oxygen steelmaking plant, the expansion has included a fourth blast furnace, a new slabbing mill, a new hot-strip mill, 90 additional coke ovens, extensive additions to the tin-plate mill, new facilities to produce wider steel plate, and mine improvements.

Electrostatic Microfilm Enlargements

A new compact reproduction machine that makes working-size enlargements of 35-mm microfilm drawings and records by the electrostatic reproduction process has been introduced by the Charles Bruning Company, Inc., of Mount Prospect, Ill. It requires no inks, stencils, plates, accessory equipment, or darkroom facilities, and the cost is only a few cents per print.

Enlarging and printing are done continuously and the Copytron Model 1000, as the machine is called, has a production rate of 3 to 4 copies per min.

Prints are in black and white on standard-size sheets, ranging from $8\frac{1}{2} \times 11$ to 18×24 in. Additions and revisions can be made on the print just as on regular paper. An inexeprienced operator can make them easily, quickly, and inexpensively.

The operator simply inserts reel, strip, or card-mounted microfilm and feeds Copytron paper into the machine. A magnified scanner permits the operator to view the microfilm image before a print is made.

The Copytron uses a special paper that becomes photosensitive when electrostatically charged by rollers in the machine.

Wherever light is blocked, the charge is retained. The image is dry-developed, using a plastic-resin black "toner" or powder which forms a positive black-line enlargement. By changing the toner, direct enlargements can be made from positive films. The image is heat-fused to the paper by heat, making an impression as permanent as printer's ink.

Copytron enlargements can be used for direct reference and distribution. They also can serve as short-run masters for making up to 50 additional reproductions on offset-printing machines. A sensitized Copytron paper to be used as a long-run offset master is now under development.

Herbert F. Bruning, president, and Paul J. Bruning, chairman of the board, Charles Bruning Company, Inc., examine prints

After inserting microfilm and selecting the print size the operator simply feeds Copytron paper into the machine. Operation is automatic.

New Sintering Theory

A NEW THEORY which may greatly affect the future development of powder metallurgy was presented by Henry H. Hausner, consultant to Los Alamos Scientific Laboratory, at a meeting of the Los Alamos Chapter of the American Society for Metals.

According to Dr. Hausner, two different movements take place during sintering of a mass of metal powders: Material movement due to diffusion which results in densification; and grain-boundary movement due to recrystallization and grain growth which results in the final grain structure of the sintered material. Both movements are to a certain extent correlated and strongly affected by the porosity between the powder particles during the sintering process. Heretofore porosity has usually been neglected in any discussion of sintering, and Dr. Hausner has shown that the variables of porosity actually widely affect diffusion as well as grain-boundary movement. In addition, the original porosity determines to a large extent the grain structure and therefore the physical properties of the sintered product.

"One can distinguish between more than ten variables in porosity, such as total pore volume, total number of pores, pore size, pore shape, interconnected and closed pores, orientation of pores, and so forth," he stated. With respect to the change in pore size during sintering, he referred to the work of Professor F. Rhines of Carnegie Institute of Technology, but emphasized that almost no consideration has previously been given to pore shape and pore orientation. Greater porosity and smaller pore size in the "green" compact contribute to a faster rate of material transportation during sintering, and at the same time to a rather smaller rate of grain-boundary movement. He further explained why a more uniform grain structure is obtained when any orientation of the voids in the compact is avoided. The new theory, which stresses the heretofore neglected porosity, will permit production of powder-metallurgy materials with closer control of, and probably better physical properties.

"Pressure-compacting probably decreases the rate of densification," and a distinction should be made between powder-metallurgy products made by sintering of pressure-compacted and of loose powders.

Dr. Hausner's own work in the sintering of loose stainless-steel powders and in the slip casting of metal powders and metal-ceramic combinations under an AEC contract confirms his theoretical formulation. Reference was also made to the recently developed process of metal-powder slip casting as a special case of nonpressed powders, and to the work of the United Kingdom Atomic Energy Authority on beryllium sintering, which resulted in a more ductile type of beryllium with improved physical properties.

Punched-Card Telephone Ordering

An ordering system that utilizes "beeps" similar to the tones used in zone dialing has been developed by Western Electric. In place of sending in vague typed or handwritten parts descriptions, telephone installation men are provided with packets of small ($2^1/_4 \times 3^1/_4$-in.) punched cards which identify any one of the more than 10,000 items which Western Electric stocks that the installer is likely to need.

A simplified card-reading machine which switches directly into the telephone line uses a multifrequency oscillator to convert the punched information into two-tone combinations of six possible tones. At the beginning of the order, the installer inserts his identification card which transmits address, limits on amount ordered, and all other information necessary for shipping and billing. As the item cards are inserted one at a time, adding-machinelike keys are depressed for the order quantity. This is the only place for possible error, since an IBM error-indicating code is sent with each transmission. This is an easily recognized standard word or symbol which indicates incorrect transmission if it does not come through properly. Positioning checks in the card reader insure the proper placement of cards before transmission begins.

The card reader at the warehouse end of the line feeds data directly to automatic typing and accounting machines which make out all necessary forms. Although the transmission is only 10 words per min, the machine methods result in greatly increased speed and accuracy of order-handling procedures. Standard receivers, amplifiers, and relays, are used and the only power supply required is the regular telephone-circuit voltage.

Western Electric developed the system solely for solving its own ordering problems, but points out that the potential applications of telephone-data transmission may lead business-machine manufacturers to incorporate the equipment into their systems. Other possibilities are centralized billing, payroll, and other procedures which lend themselves to the standardized-card transmission method.

Greaseless Automobiles

"It is currently estimated by some of the more optimistic automobile people that grease fittings will have disappeared from passenger cars by 1961," according to W. M. Drout, Jr., manager of marketing economics for Esso Standard Oil Company, in a talk before the National Lubricating Grease Institute in Chicago, Ill.

"The more conservative indicate that this will occur by 1963," he continued. Recent advances in the field of permanently lubricated or essentially friction-free bearings make this development seem possible, and all automobile manufacturers are working toward this end. There has already been a 56 per cent reduction in the number of chassis fittings in the past seven years.

Air Drilling Extended

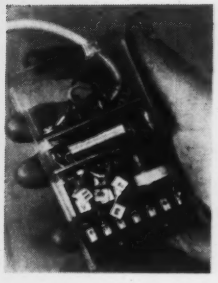
The number of oil or gas wells drilled with rotary tools while circulating air or gas—the fastest and most economical of well-drilling methods—may be greatly increased by processes developed by Gulf Oil Corporation for sealing water out of the well bore.

The significance of water shutoff lies in extending to many new fields the economies of air/gas drilling. These can cut total drilling costs for a well as much as 25 per cent through greatly increased penetration rates over those achieved in conventional rotary drilling with mud and through a tenfold increase in bit life. Air/gas has helped drive holes at averages of over 1000 ft per day in formations where water-circulating wells lumbered down at 175 ft daily.

Water shutoff in flows up to 2200 gal per hr is achieved by injecting a special gas into the porous sand which is producing the undesired water. The gas and water react in the rock pores to create a solid, water-insoluble precipitate which is 99 to 100 per cent effective in plugging the openings between sand grains for about a foot around the well bore.

Commercially available gas and simple equipment are used. Well-servicing organizations will be licensed to use the process.

Right, **punched - card telephone ordering system.** ***Below,*** **punched cards and numbered pushbuttons start the order, translated by transistorized multifrequency oscillator,** ***below center.***



Below, **throwing a key connects the distance sender to a standard business - machine card punch which records information for use in data-processing for ordering, billing, or other records**

Multiple-Wire Feed Mechanism

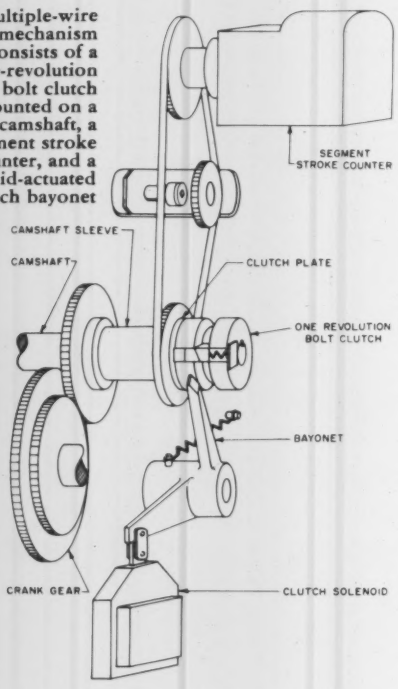
A MULTIPLE-WIRE feed mechanism developed by the Machine Division of The Torrington Manufacturing Company, Torrington, Conn., increases the feed length on segment-type coilers, through automatic multiple-stroke feed, so that all the most common long springs can be coiled accurately and rapidly to any desired length. Retaining the use of pitch, diameter, and cutter mechanisms and the inherent accuracy of segment-type coilers, compression and extension springs (open or close-wound) with plain, squared, tapered, and coned-down ends can be produced up to twice as fast as by a clutch-type coiler of equivalent size.

The multiple-wire feed mechanism can be used with any set of extra wire-feed gears that can be mounted on the basic machine. Standard cams can be used and, when a spring is being set up or adjusted, only that portion requiring camming need be coiled. A substantial saving in wire during setup can result, particularly on longer springs. Long torsion springs can be produced by use of an internal-support rod.

The principle of operation of the multiple-wire feed mechanism is simple: When the required wire feed exceeds the capacity of one stroke of the segment, succeeding strokes occur until the necessary wire length has been fed, after which the cut takes place. Pitch and diameter camming is possible during the first half of the first stroke and last half of the last stroke.

On the Torrington W-11A Spring Coiler, for example, the maximum wire feed for 0.072-in. wire is 42 in. With the multiple-wire feed mechanism, a full wire length of 160 in. can be coiled by setting the segment for a 40-in. feed and setting the counter to 4. Changes in pitch and diameter can be made in 20 in. of wire on either end, and only 40 in. of wire need be coiled during setup.

The multiple-wire feed mechanism consists of a one-revolution bolt clutch mounted on a camshaft, a segment stroke counter, and a solenoid-actuated clutch bayonet



Glass as Structural Member

CONTINUED RESEARCH should produce a transparent laminate which, when combined with glass, will result in a transparent composite capable of functioning as a structural member in automobile bodies, according to George B. Watkins, chairman of the technical policy committee of Libby-Owens-Ford Glass Company, in a paper before the recent Annual Meeting of the SAE.

"The future transparent interlayer should have the necessary mechanical strength so that its extension at the edges will serve for mounting purposes, thereby carrying the load placed on the glass composite without distortion or plastic flow," Dr. Watkins continued.

Although well-annealed plate glass and sheet glass of the soda-lime-silica type have a tensile strength of 6000 psi and much greater compressional strength, they have a wide variation of breaking loads as compared with metals in tests. The chemical durability of glass rates very high.

Glass is not a true chemical compound but rather a fused homogeneous mass of mixed oxides, and vast numbers of combinations of different ingredients are possible.

In spite of many years of research, there are still many unanswered questions regarding the behavior of glass. Why is glass transparent? Why do we obtain different values for the bending strength of glass specimens cut adjacent to each other from the same plate or sheet? Why is glass a poor conductor of electricity in the solid state?

Rapid advances being made in solid-state-structure studies may soon give the answer to many anomalies.

Heat Pump Needs Improvement

THE all-electric home as a "mass-market reality" depends on a "substantial improvement" in the annual coefficient of performance, COP, of the electric heat pump, according to Constantine W. Bary, economic analysis engineer, Philadelphia Electric Company, in a paper presented at the AIEE Winter General Meeting.

COP for the heat pump was defined as the ratio of the total useful heat output (heat absorbed at low temperature plus the heat equivalent of work done) to the equivalent heat of electrical energy output.

It is almost universal practice for manufacturers to provide relatively large amounts of supplementary resistance heating in conjunction with air-source heat pumps. Continued research has revealed some new load and economic aspects which are believed to be of vital significance in the economics of supplying electricity to this device.

Cost-to-serve levels of resistance-type systems, Mr. Bary said, fall "far short" of meeting competitive operating costs. Of all systems considered, the heat pump with supplementary heat storage provides the lowest cost-to-serve level and, at an annual COP of approximately 3, approaches the "reference band" of competitive operating costs.

Substantial improvement in the annual COP of the heat pump, development of supplementary heat-storage means, the discouragement of the use of supplementary resistors, and the meeting of the economic necessities of long-range considerations are still necessary if the heat pump is to be competitive.

7-Lb Analog-to-Digital Converter

A 7-LB completely transistorized Multi-Channel Analog-to-Digital Converter, Model CG 591, has been developed by C. G. Electronics Corporation, Albuquerque, N. Mex., a subsidiary of Gulton Industries, Inc., Metuchen, N. J. Although designed for airborne applications requiring analog-to-digital conversion, the unit is adaptable to many process and other applications.

The system attains accuracies of 0.2 per cent and can be made compatible with any computer code because of its building-block construction which uses modular techniques and permits a relatively small number of subsystems to be combined to form custom systems for particular applications.

Basic units are 2 × 3-in. plug-in, etched-circuit cards which are easily installed or replaced and provide longer life and increased reliability. Outputs can be furnished for magnetic tapes, punched tapes, punched cards, visual readout, or transmission over telemetry links.

Various combinations of circuits, such as flip-flops, mono or bistable vibrators, AND, OR, and NOT gates, and emitter followers, comprise the desired subsystems. Subsystems of decade counters, ring counters, command units, parity checkers, and the like, constitute the complete analog-to-digital converter.

Featuring built-in transient surge protection, the converter is adaptable to on-line entry into digital computers, which not only saves valuable time but eliminates errors encountered in reduction of information.

Designed to receive 12 inputs normally, 50 or more can be scanned depending upon the scan rate required. The binary coded decimal form of transmitting information requires only seven discriminators, independent of the number of transducers scanned. The scan rate ranges from 100 to 300 cps with possible response rates as high as one megacycle.

Designed to measure analog voltages, the converter has a volume of only 0.17 cu ft (7 × 3 × 14 in.). Read in sequence, the encoder converts each analog voltage to its digital equivalent which is translated into decimal form. Through the use of amplifiers or attenuators, voltage ranges other than those specified can also be handled.

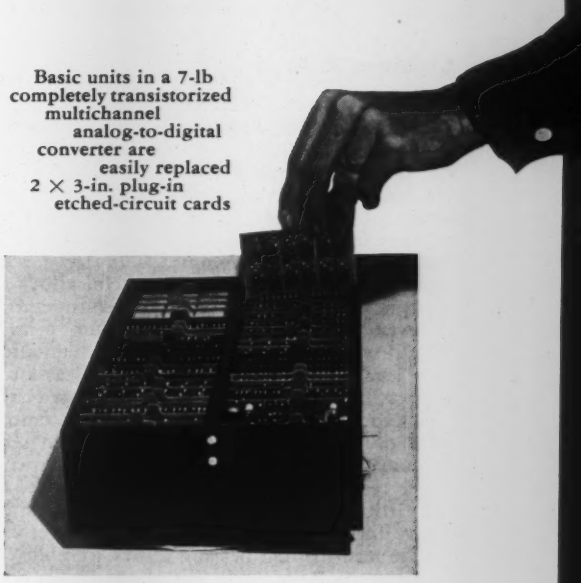
Additional specifications for present units include a range of input voltages up to 10 and an operating-temperature range of 20 to 165 F. Voltages up to 1000 can be handled on special order.

Present systems require approximately 1.5/1000 millisec to make a measurement, but systems that require only 15/1,000,000 microsec are being investigated.

NBS Multicomputer Network

MANY large-scale data-processing jobs, for which solutions are now urgently required, call for much faster computing capabilities than presently available machines can provide. In order to shorten problem solving times, the National Bureau of Standards has connected together several computers into an integrated network which divides up the total task into different pieces, on which different computers work simultaneously.

An instruction system has been devised for carrying out such collaborative operations effectively. Summary technical report no. 2302, February, 1959, is available from the NBS.



Basic units in a 7-lb completely transistorized multichannel analog-to-digital converter are easily replaced 2 × 3-in. plug-in etched-circuit cards

Rotor Balancing

A TURBINE ROTOR-BALANCING METHOD developed at General Electric's Small Aircraft Engine Department, Lynn, Mass., cuts cost and assembly time by more than 50 per cent on rotors of gas-turbine aircraft engines according to the *Industrial Research Newsletter* of Armour Research Foundation. In the former method, the turbine rotor was balanced by picking and choosing blades—all the same size but not necessarily the same exact weight—until the right ones were found. In the new method, 10 to 15 miniature, sintered-metal slugs are installed with tweezers on each rotor at points of unbalance determined beforehand by the balancing equipment and a unique analytical technique developed by G-E engineers, Seymour J. Feinberg, Assoc. Mem. ASME; Frank E. Pickering; and Walter H. Sanderson.

Combustion-Gas Turbine

A $2-MILLION, 20,200-kw combustion-gas turbine has been ordered by the New Orleans Sewerage and Water Board from General Electric Company's Gas Turbine Department, Schenectady, N. Y.

The unit is specifically engineered for low-cost power generation to meet peak demands for electricity in the expanding utility system of the Sewerage and Water Board. It is adapted from a 16,500-kw simple-cycle, single-shaft machine of which nine have already been ordered or installed.

One of the largest capacity industrial-load gears yet produced will connect the gas turbine to the generator and reduce the gas-turbine speed of 3600 rpm to 750 rpm. The gear will be approximately $7\frac{1}{2}$ ft long, and have a width of 10 ft. It will be manufactured by General Electric's Medium Steam Turbine, Generator and Gear Department, Lynn, Mass.

The air-cooled, totally enclosed 23,765-kva, 3-phase, 25-cps generator will be produced by the Company's Large Motor and Generator Department, Schenectady, N. Y.

Lithium Alloys

In the light of recent research, lithium, lightest of all metals, has turned out to be a highly promising alloying material, according to an article by Paul D. Frost in the *Battelle Technical Review*.

Considerations of solubility, cost, availability, strength, and other factors suggest that the most important lithium alloys of the future will be made from magnesium and aluminum. The large solubility of lithium in silver could lead to useful alloys for applications in which cost is a secondary consideration.

Several important uses of lithium prior to World War II were in a high-strength aluminum alloy, Scleron; in a lead-bearing alloy, B-metal; and as a scavenger in copper. However, these applications used little lithium.

Scleron was reported to have strength comparable with that of the copper-hardened Duralumin series of aluminum alloys. It contained about 12 per cent zinc, 2 per cent copper, 0.5 per cent manganese, and 0.1 per cent lithium. The alloy was developed and used in Germany during World War I, but is no longer used.

The lead-lithium bearing alloys were developed early in Germany, apparently out of a necessity to find a substitute for alloys containing tin. Lithium is only slightly soluble in lead and small additions effect considerable hardening. The bearing alloy, B-metal, contained about 0.04 per cent lithium, 0.73 per cent calcium, 0.66 per cent sodium, 0.03 per cent potassium, under 0.2 per cent aluminum, balance lead.

Perhaps the most promising use that can be visualized for lithium alloys as a shielding material is for nuclear reactors and as an agent in producing tritium.

Within the past year, the Aluminum Company of America has made available, in experimental quantities, a new aluminum alloy designated X-2020-T6 in which 1.0 per cent lithium is the most important addition.

The alloy is being evaluated at the present time by a number of aircraft companies. Interest is high because it has better strength, particularly at elevated temperatures, a higher modulus of elasticity, and lower density than the strongest current aluminum alloys.

Like other high-strength aluminum alloys, X-2020 is a heat-treatable material and attains its highest strength by a solution and age-hardening cycle. Unlike 2024 which has to be refrigerated to prevent age hardening, it hardens very slowly at room temperature. After one week following the solution treatment, the tensile strength increases only about 5000 psi, permitting sheets to be solution treated and subsequently formed in the soft condition at any time. Corrosion resistance is similar to that of 2024, and cladding can be used.

Alloys of magnesium and lithium may, in the future, consume more lithium than any other application visualized at this time. Alloys containing up to 10 or 15 per cent lithium are being investigated for possible use in aircraft, missiles, and other applications. Lithium is the only element capable of converting the hexagonal lattice structure of magnesium to the more ductile body-centered cubic structure. Lithium in magnesium improves ductility and markedly lowers its density.

Obviously more studies are required to tailor lithium alloys for specific applications in order to achieve the desired results. It would appear, however, that if sufficient incentive is provided, such as the current need to reduce weight in aircraft, new applications for lithium will arise.

Materials Briefs

▶ Steel-Like Material

"CentraSteel," a novel experimental steel-like material that may offer engineers a replacement for plain steel forgings and permit design flexibility of castings, was reported at the recent American Foundrymen's Society Wisconsin Regional Conference.

A patent application has been filed for the material developed co-operatively by General Motors Central Foundry Division and GM Research Laboratories.

CentraSteel has a 28-million-psi elastic modulus, very nearly equal to steel, plus equivalent strength, better machinability, and castability apparently superior to steel. Its outstanding characteristic is the presence in the as-cast condition of a compacted type of graphite similar to the temper carbon found in malleable iron.

It does not require extensive heat-treatment, explosive or costly addition agents, injection apparatus, or low maximum sulfur content. Some foundry problems remain to be solved, however, for high volume production, and work on them is under way.

Absence of massive carbide makes use in the as-cast condition possible, and the new material is produced by inoculation with boron and tellurium of a low-carbon, high-silicon-base composition.

This high-silicon low-carbon content of CentraSteel is the reverse of normal iron-founding experience, but the proportion of carbon and silicon gives the material its high modulus and great versatility.

Its preferred composition includes 1.70 C, 2.25 Si, 0.40 Mn, 0.10 S, 0.05 P, and 0.01 boron.

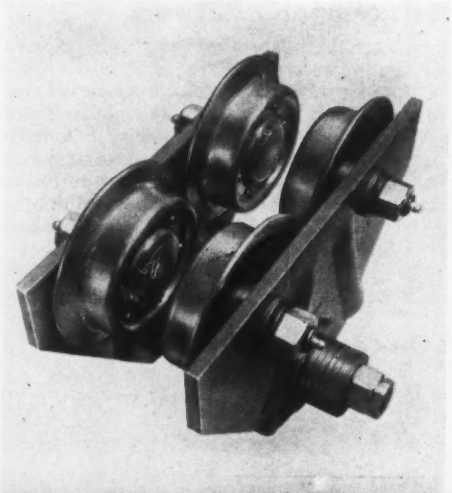
CentraSteel is readily amenable to heat treatment to obtain a wide range of properties.

▶ Nonsparking Beryllium-Copper Wheels

The sparking of conveyer and chain-hoist trolley wheels in explosion-hazard areas has been eliminated by Saginaw Products Corporation, Saginaw, Mich., with the use of a beryllium-copper alloy.

The Berylco 25 alloy, used only for the outer shell of the wheel, is heat-treated after the wheels have been formed, and serves both as a wearing surface and to separate steel components from the steel track. The nonsparking, nonmagnetic, corrosion-resistant alloy has a 165,000-psi tensile strength, 36 Rockwell-C hardness, 22 per cent minimum electrical conductivity, and an elongation of 5 per cent in 2 in.

Nonsparking beryllium-copper shells of wheels for a four-wheel chain-hoist trolley receive wear from track and from ball bearings in the wheel



▶ Cadmium Coating Prevents Hydrogen Embrittlement

High-tensile steels can be protected against corrosion without danger of hydrogen embrittlement by a new low-cost method for vacuum deposition of cadmium. Developed jointly by NRC Equipment Corporation, Newton, Mass., and its parent National Research Corporation, the new method compares with electroplating in respect to process cost and quality of coating.

The process is expected to find immediate application in the aircraft industry for use on parts made of high heat-treat steels, which tend to become embrittled when electroplated. Automotive products, industrial machinery offer potential applications.

NRC Equipment Corporation will supply both process information and vacuum-plating equipment to user requirements, including that to meet military specification Mil-C-8837 (ASG), for vacuum-deposited cadmium coating on military aircraft parts.

▶ Sea-Water Corrosion Protection

A new M-87 Magna-Bar alloy has been developed by the Johns Manufacturing Company, Middlesex, N. J., for the anodic protection of iron and steel tanks contaminated by sea water. Corrosion of oil tanks and tankers which have been ballasted or cushioned with sea water will be protected for about 10 years with an 8-lb anode, compared with the 3-year protection afforded by a 60-lb anode of high-purity magnesium.

The M-87 alloy "plates" a whitish film onto the iron and steel surfaces and causes the precipitation of soft snowlike material from the sea water which can easily be handled by the pumps. No chipping of hard deposits is required.

▶ Vinyl-Coated Steel Sheet

Liquid-vinyl plastisols are cured and bonded to sheet steel in a continuous coating process developed by United States Steel.

The surface can be embossed with any texture that can be engraved on a printing roll, and can be produced in any specified color with assurance of color uniformity. One large-volume use anticipated is for the imitation of the leather finishes currently popular in automobile interiors. Other uses would include small cabinets for radios and electric heaters as well as potential architectural interior and furniture use.

Fabrication of the material can be accomplished in much the same manner as with cold-rolled sheet, without damage to the coating or effecting a color change. The product is scuff resistant and most common staining agents have no effect.

Sheets are available in 18 through 28 gages and in widths from 24 to 52 in. with lengths from 30 to 144 in. Coils are also available.

▶ Adhesive-Bonded Scrap-Metal Pattern

Structural metal-to-metal adhesives are being used to salvage once-discarded scrap tooling metal by Ryan Aeronautical Company of San Diego, Calif., with annual savings of over $20,000.

Ryan engineers conceived the idea when aluminum castings and patterns—needed in a hurry—could not be delivered in less than six weeks. A workable mold was ready within 10 days.

The same pattern-making procedure is used by which wood blocks are glued together to build a forming block. Scrap pieces of cast-aluminum tooling metal are bonded together with a structural aircraft adhesive, Narmco Metlbond 4041. This consists of an elastomer-modified phenolic in unsupported-film form plus a liquid-metal prime, and is manufactured by Narmco Resins and Coatings Company, Contra Mesa, Calif.

Strength characteristics are such that a bond has never been torn apart regardless of the severity of the cut during machining tests.

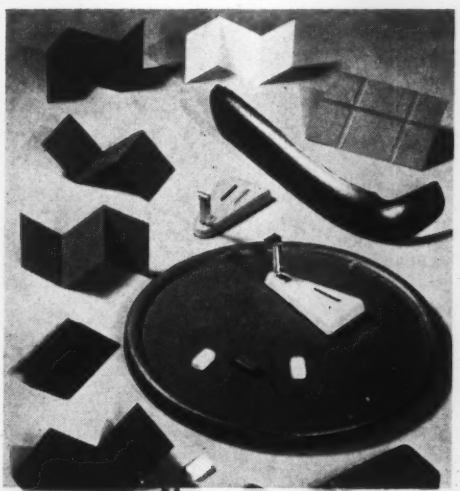
▶ Plastic Mirrors

Epoxy-resin aluminum-coated reflective optical components have been announced by the Singer Military Products Division, New York, N. Y.

A negative that is cast from a precision-ground glass master mirror is used as a mold for casting positive replicas. Both negative and finished product are made of the special epoxy-resin formulation. Reflective surface is an aluminum coating applied in high vacuum and overcoated with a protective film.

The product, named the Repli-Kote Mirror, faithfully duplicates the most intricate configuration, while its essential physical properties are far superior to those of glass. For example, in shock-resistance tests, epoxy samples have withstood as much as 22,000-g impact. Yet precision has been attained in mass manufacture of 6-in. paraboloid mirrors with a $5^1/_4$-in. focal length that concentrates 90 per cent of incident collimated light within 0.1-mm diam.

Vinyl-coated steel, available in sheet or coil, can be fabricated in the same manner as cold-rolled sheet without marring the finish



Epoxy-resin aluminum-coated reflective optical components have excellent shock resistance with optical properties similar to glass

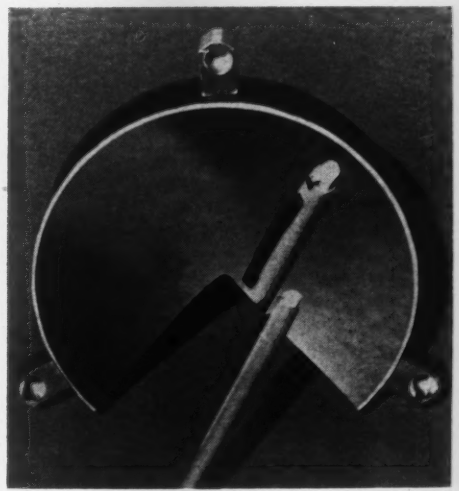


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PHOTO BRIEFS

1 Suction Stacker. Thin 7-mil-thick aluminum fins jammed in chute feeding. Westinghouse now uses suction to hold them during transport from the press. When the vacuum is momentarily broken, they are dropped and stacked onto guide rods.

2 Shot Cleaning. Irregularly shaped steel shot is cascaded through tubular air heaters and over horizontal surfaces such as superheaters, economizers, and reheaters to remove ash and soot in the system manufactured by Diamond Power Specialty Corporation, Lancaster, Ohio. Heavier particles fall into the hopper and recirculate with the shot until broken fine enough to pass out with the gases. Shot cycle can be continuous, if necessary, without disturbing boiler operation.

3 Exact Extrusion Temperatures. A metered-Btu system which measures watt-hr input to the billet, and determines the amount of energy absorbed, is used in Lindberg Engineering Company's induction billet heater. No prod-type thermocouple is needed, and smooth stepless power control is provided.

4 Drive Gear for Nuclear Ship. The DeLaval cross-compound steam turbines of the *NS Savannh* will drive the ship's single propeller with the 583 gear teeth of this 70,000-lb, 176-in-diam, 48-in-across main drive gear, also made by DeLaval.

5 Four-Machine Team. All the openings in both sides and ends of cast-iron tractor transmission cases are completed by a four-machine team built by Buhr Machine Tool Company, Ann Arbor, Mich. Each machine has a 1.6 to 2.8-min cycle time including loading and unloading. Use of four machines allows arrangement in any order for best possible work-flow pattern.

6 Teeming Teamed. Two ingots are poured simultaneously in half the former time with two Blaw-Knox hydraulically powered remotely controlled Autopours

7 Welded-Stud Fasteners. A special fixture and a two-gun production stud welder made by Gregory Industries, Inc., Lorain, Ohio, cut production costs over other fastening methods. Four Nelson studs link the bell cranks to the yokes,and four more are end welded to the other end of the cranks to serve as axles for the mower wheels. These can be raised or lowered with the pedal and ratchet on the yoke to adjust the height of the cut.

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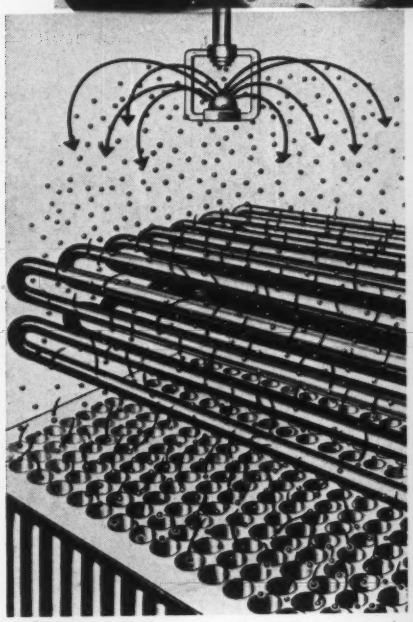

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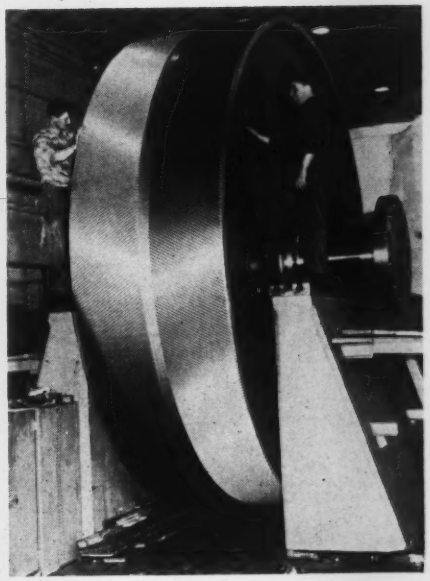

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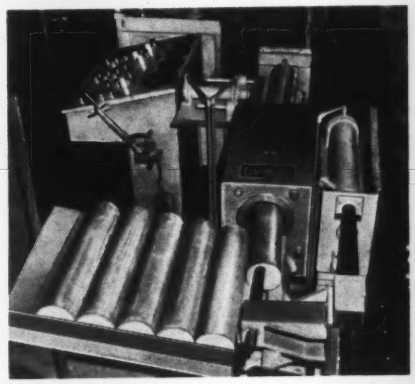
More Briefs on next page ▶



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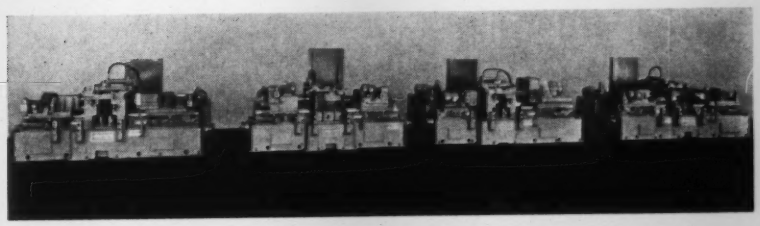

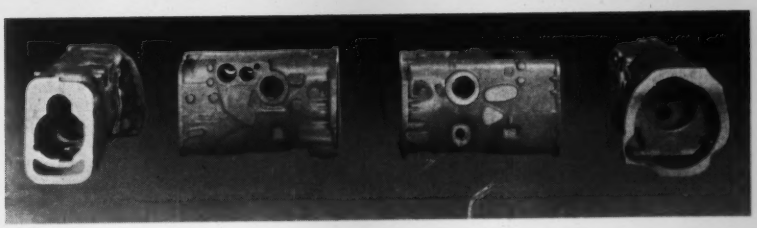

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PHOTO BRIEFS

8 Aluminum Condenser Tubing. Aluminum tubing is being installed by Alcoa in a 75,000-sq-ft 812,819-lb-per-hr condenser for a 156,250-kw Westinghouse turbine generator at the Armstrong Station of West Penn Power Company, Reesedale, Pa. Substantial initial-cost savings, quicker installation, and some corrosion advantage—particularly on the steam side—are among the advantages.

9 Jet Silencer. A portable run-up silencer made by Koppers Company, Inc., Baltimore, Md., requires no attachment and can be put in place in 2 min. Noise is reduced 30 db—equivalent to 90 per cent reduction of the impact on the eardrum. Mono-Block insulation made by Baldwin-Hill Company, Trenton, N. J., being applied, withstands 1700 F. A single 2-in-thick layer insures outer surface temperatures below 200 F. Density of the material is only 15 lb per cu ft.

10 Process Precipitators. Precipitators made by Koppers Company, Inc., and equipped with Koronamax controlled-corona discharge electrodes remove 96 per cent of the particulate matter from 29,900 cfm of coke-oven gas in producing naphthalene.

11 Hypersonic Wind Tunnel. Speeds up to 5940 mph will be simulated in the hypersonic wind tunnel Westinghouse is building for CalTech's Jet Propulsion Lab. Vertical sections, ***top and bottom,*** are parts of jacks used to set or alter the shape of the test section by moving heavy steel-alloy plates.

12 Electricity and Fresh Water. Pilot-plant equipment to be installed by Cleaver-Brooks Special Products, Inc., will convert sea water to fresh water at the $57-million Mandalay Steam Station near Oxnard, Calif. The station's two 220,000-kw electric generating units will supply electricity to California Edison.

13 Multipurpose Fighter Plane. Mock-up of the N-156F multipurpose supersonic fighter which Northrop is under contract to develop specifically to meet the defense needs of the free allied nations. Designed to operate economically and from short and relatively unprepared airfields, it can use a variety of advanced armament. Maximum exploitation is made of newly available high thrust-to-weight-ratio engines.

14 Tough TV. Intense vibration, 50**g** acceleration, and 40**g** shock do not affect a miniature battery-powered TV system developed by Lockheed for missile service. The 9-lb set has a 1000-mile transmitting range and transmits a perfect test pattern under full vibration.

15 Automatic Loading. A hydraulic plunger inserts work from the loading chute into the collet chuck at one of four stations of the rotary fixture on a Heald Model 221 Bore-Matic. Table travel rotates the fixture in 90-deg turns for machining both ends of a roll sleeve with an idle intermediate station. In operation, a bore and face are finished, a recessed groove is generated, and 0.012 to 0.018 in. of stock are removed from the bore diameter.

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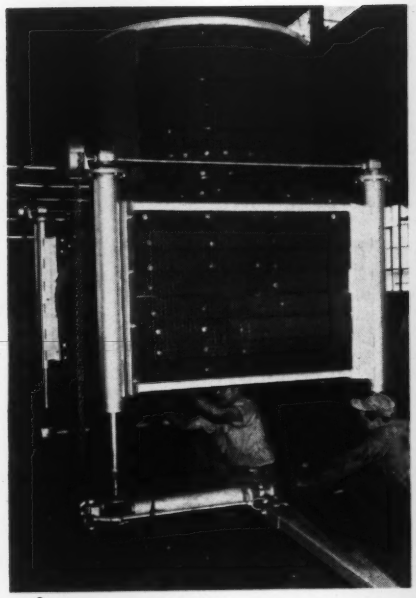

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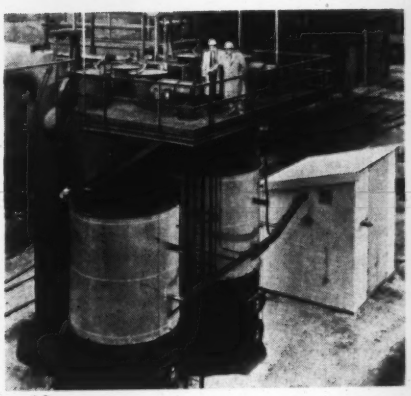

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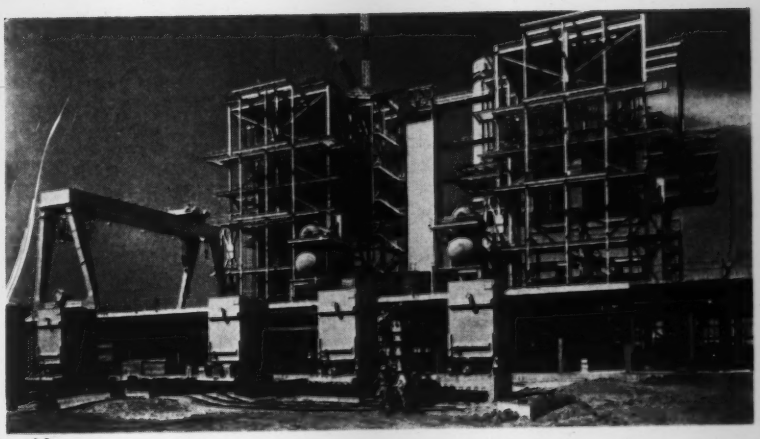

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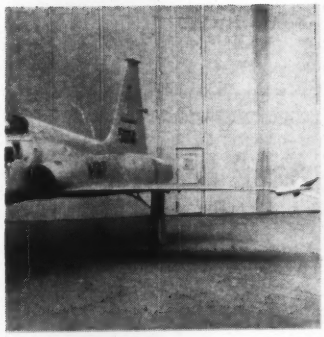

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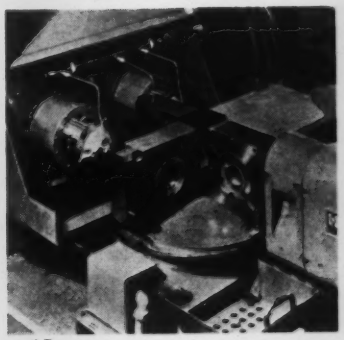

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Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

Self-Setting Surveyor's Level

TWO OLD-ESTABLISHED British firms of scientific-instrument makers have collaborated in the design and development of an optical stabilizer for incorporation in the telescope of a surveyor's level, to effect automatic compensation for small errors in leveling. They are Cooke, Troughton & Simms, Ltd., of York, a subsidiary of Vickers Ltd.; and Hilger & Watts, Ltd., of London.

The moving part of the compensator, which is fitted inside the tube of the telescope, consists of two reflecting prisms suspended by four flexible metal strips; in effect, it forms a flexure-pivot and, being frictionless, always returns to the correct position, allowing the compensator to come to rest in the vertical plane in a fraction of a second, and with a sensitivity of less than a second of arc. A damper restricts the movement of the swinging part to 20 seconds of arc, and serves also to take the weight of the swinging part when the instrument is in transit.

In using the instrument, all that is necessary is to level it approximately by means of the circular spirit vial; the stabilizer then sets the line of sight in a horizontal plane precisely and instantly. The level is consistently accurate within a temperature range from − 30 C to + 50 C. Compared with a conventional level, the time of operation is halved.

An accuracy of 0.02 ft per mile is easily attained, and with ordinary skill and care in double leveling an average closing error of 0.004 ft per mile is practicable. The telescope has a magnification of × 32, an aperture of $1^{9}/_{16}$ in., and a field of view of 1 deg 20 min.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Heavy Swamp Tractor for Oil Prospecting

A SWAMP TRACTOR originally designed to the specification of the Shell Petroleum Company for use by the Shell Oil Company of Canada, Ltd., for exploration work in the Canadian muskeg territory is to be employed for similar work in Nigeria.

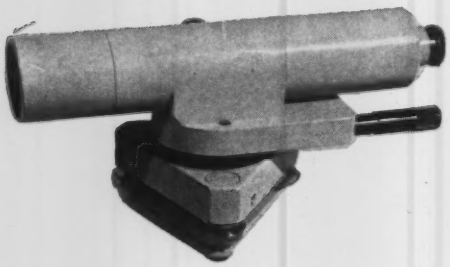
The prototype was constructed by the Scottish firm of James A. Cuthbertson, Ltd., of Biggar, Lanarkshire, but the tractor for Nigeria has been built by Albion Motors, Ltd., in their works on the outskirts of Glasgow. It is known as the Albion-Cuthbertson "Water Buffalo," and is intended for hauling trailers containing drilling equipment; two of these trailers will accompany the machine, one with load capacity of 28 tons and another 10 tons.

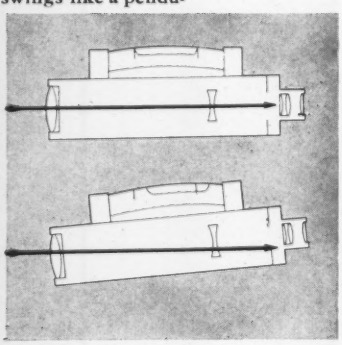
The tractor is driven by a Leyland diesel engine of 150 hp, capable of developing a torque of 450 lb-ft and has semirubber tracks which will flex freely in every direction. Except for the tank-type undercarriage, all the mechanism is enclosed in the welded steel watertight body, which can be fitted with side extensions to make it amphibious for use in deep water. The trailers also will float when fully laden.

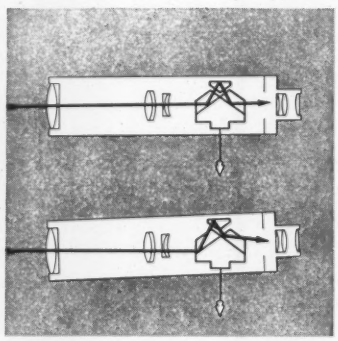
Though the tractor weighs about 20 tons, the ground pressure on the tracks is only $1^{1}/_{2}$ to 2 lb per sq in.—less than a third of that of a man. It is fitted with a bulldozer blade, an A frame at the rear for use as a crane, and a powerful capstan and reels of wire rope with which to winch itself and the trailers out of particularly difficult patches of ground.

The tracks, which are 4 ft wide, are driven at the front end through a Leyland Pneumo-Cyclic semiautomatic gearbox and a centrifugal clutch.

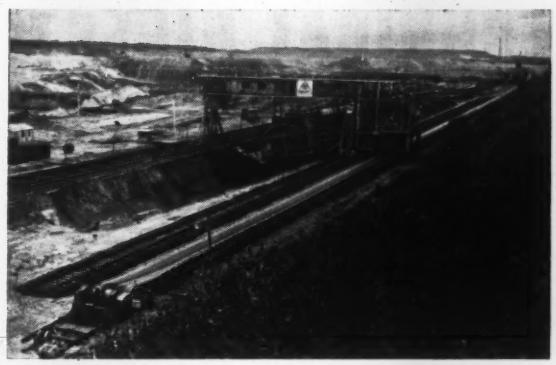
Self-setting level, *left*. With conventional level, *center*, if telescope is tilted, points on level line are seen above or below the crossline. In "Autoset," *right*, there is a stabilizer consisting of two prisms on a suspended mount; when telescope is tilted, stabilizer swings like a pendulum and keeps the horizontal ray on the crossline.





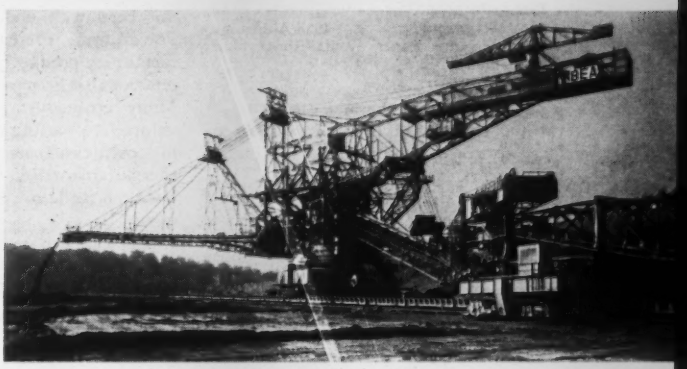


Trains of 100-ton dump cars arrive on far track and are tipped into dump trench. Bucket-wheel excavator travels along trench, digging out dumped material and discharging it into belt conveyer *in foreground.*



Conveyer is shown being dragged sideways to a new alignment by means of a LeTourneau tractor

Conveyer for brown coal and overburden. Whole conveyer can be skidded sideways to a new location.



Spreader depositing overburden from a brown-coal mine. Pickup conveyer, *on right,* transfers material from another conveyer to the distributor, which spreads it over a wide arc in bottom of pit to be filled.

Overburden Disposal in Mining Brown Coal

In last month's "European Survey" a description was given of a giant bucket-wheel excavator, manufactured by Fried. Krupp Maschinen- und Stahlbau, Rheinhausen, Germany, and used for mining brown coal in the Cologne coalfield in West Germany.

To get at the coal, which lies in beds from 30 to 35 ft thick, it is necessary to remove about three times that thickness of overburden, which is disposed of by dumping it in abandoned coal workings, often at a considerable distance.

For this purpose the firm has developed a system of belt conveyers. The trains of dump cars which are filled by the excavator are tipped into a long trench, straddled by a small traveling bucket-wheel digger, moving along the trench and discharging onto a belt conveyer, laid parallel with the tracks of the excavator. A pickup conveyer transfers the material to another conveyer which (possibly with one or more similar transfers en route) delivers it to a distributor, which spreads it over a wide arc in the bottom of the pit that is to be filled. This distributor is mounted on crawler tracks, as also are the pickup units, so that it can travel anywhere over the dumping area; and, though the spoil as deposited is so soft that a man will sink in it up to his knees, the specific loading of the tracks is so small that the weight of the distributor and the conveyers is easily supported.

As the distributor travels over the dumped spoil, the conveyers (which may be a kilometer or more in length) must be moved to suit. This is done by an ingenious method. The conveyers are carried on steel skids, disposed similarly to railroad ties and capable of being moved sideways. Parallel with the conveyer and attached to the ends of these skids is a steel rail. A heavy tractor (on the installation visited, a LeTourneau machine) is brought up to the conveyer. It is fitted with a side gantry carrying an arm, at the end of which are two rollers, with their axes vertical, running one on each side of the rail on the skids. Thus, by steering away from the original line of the conveyer, the tractor is able to pull it sideways, as shown in the accompanying illustration. The largest size of these conveyers is capable of handling 14,000 tons an hour. ●

Substances in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Power

Thermal Distortion of Turbine Rotors.....58—A-270

By D. P. Timo, Mem. ASME, and D. F. Parent, Mem. ASME, General Electric Company, Schenectady, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The problem of thermal distortion of turbine rotors has been of concern to large apparatus manufacturers for a number of years.

"Thermal distortion" may be defined as shaft eccentricity or runout which is temperature dependent. In other words, the amplitude of bowing of a shaft is a function of the thermal conditions in the shaft, and hence corrective measures (such as balancing) made at one temperature condition are invalid at other temperature conditions encountered by the shaft in service.

The causes of thermal distortion have not been well understood in the past. For example, the great effect on thermal instability produced by minor surface alterations has been particularly mystifying. Many erroneous conceptions have developed. Various investigators have proposed explanations for some types of thermal distortion, but so far no attempt has been made to present a unified treatment.

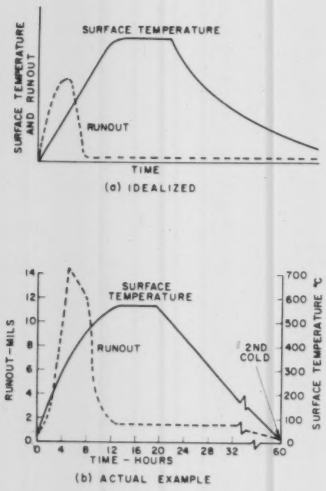
It is the purpose of this paper to show that practical cases of thermal instability fall into one of four basic types, and that the cause of each type is a nonuniformity of a thermal or mechanical property.

Each type is discussed according to its behavior in the "heat-indication test" or "heat-lathe test."

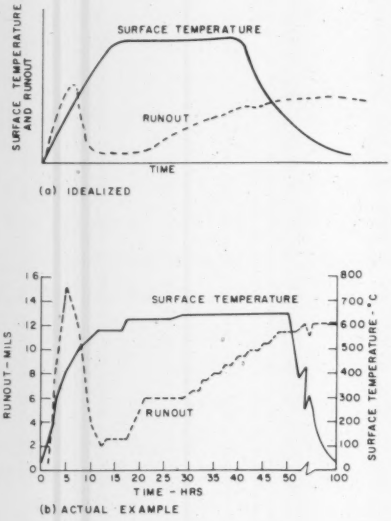
Turbine rotors are subjected to the heat-indication test before being released for production. This consists of enclosing the body of the rotor within a furnace, with the ends protruding and supported in a lathe. The surface temperature of the rotor is raised at an approximately linear rate of about 100 C per hr while the rotor is rotated very slowly (about 2 rpm).

Hourly readings of runout are taken at four peripheral points 90 deg apart. Runout is twice the eccentricity, or twice the amount of bowing or deflection from the line through the points of support.

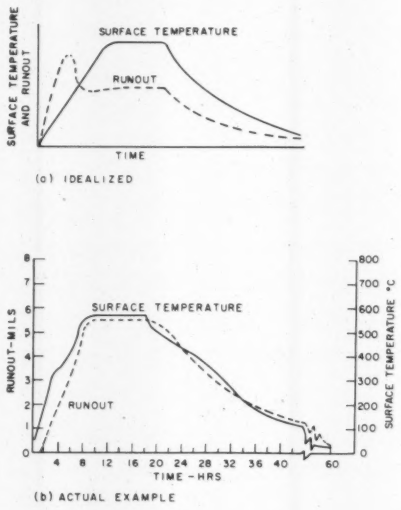
Thermal Distortion, Type A, is "cured" by heat-indication test. Runout undergoes an initial increase, then a rapid decrease, while surface temperature is still increasing. (58—A-270)



Thermal Distortion, Type B, undergoes same "curing" of nonuniform surface emissivity as Type A, but runout then increases gradually to a sizeable value (58—A-270)



Thermal Distortion, Type C, runout is dependent on temperature level, not rate of temperature change, and is due to a tangential nonuniformity of coefficient of thermal expansion (58—A-270)



Readings are taken at several axial positions along the length, during heating, and while the rotor is at constant elevated temperature. Readings are not usually taken during cooling. It has been believed that the heat-indication test "stabilizes" rotors.

Generally, however, the heat-indication test by itself is not sufficient, and a complete new heat-treatment is required to eliminate these difficulties. Thus the chief function of the heat-indication test is to discover cases of permanent thermal instability rather than to cure them.

It is of interest, then, to consider how the heat test may be modified so as to improve its ability to detect unstable shafts and to eliminate the ambiguities. To this end, a number of precautions are suggested.

Thermal Distortion, Type D, is due to tangential nonuniformity of thermal diffusivity of the rotor material. Runout is caused only during transient temperature part of heat test. (58—A-270)

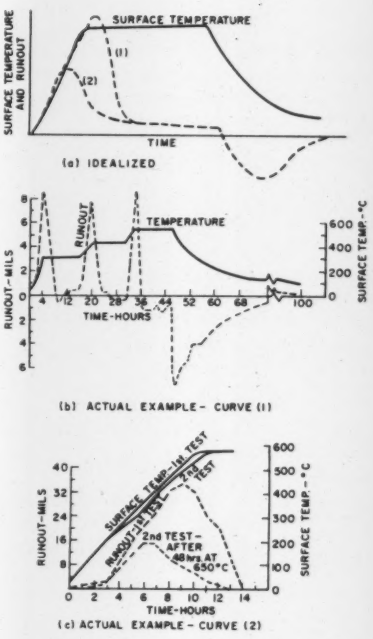
A Comparison of Cross and Counterflow Cooling Towers. 58—A-206

By Joseph Lichtenstein, Mem. ASME, Burns and Roe, Inc., New York, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The cooling tower is a "heat exchanger" in which water is brought into direct contact with the cooling medium, atmospheric air. Direct contact results in the exchange of two heat streams. One is due to convection caused by the temperature difference between the media. The other is due to diffusion, caused by the partial pressure difference of a film of saturated air at water temperature above the water surface and the atmospheric air.

In cooling-tower theory the two heat streams are combined and the heat exchanged is expressed as being equal to a diffusion coefficient K, to the interface between the media (aV), and to a potential which is the difference between the enthalpies of the media in contact with each other ($h_w - h$). The total heat exchanged in the tower is the sum of the heats exchanged at each differential surface. The mathematical process of summation or integration depends on the relative path between water and air, that is on the manner in which h_w and h are changing along the path of flow. In practice only two types of relative flow patterns are encountered, namely, counterflow and crossflow.

It is, therefore, desirable to bring them both on a common basis of calculation to facilitate comparisons in economic evaluations. The paper develops a method which extends the graphic calculations of counterflow towers to the crossflow. It then employs the method to make some comparisons of surface requirements and performance of the two towers when both are designed for the same set of cooling conditions.



Shot Cleaning—Its Development and Use for Cleaning Economizers, Tubular Air Heaters, and Applicable Boiler Sections. . . . 58—A-104

By R. E. Chappell, Mem. ASME, Diamond Power Specialty Corporation, Lancaster, Ohio; and R. D. Meyer, Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Shot cleaning has many advantages over the conventional cleaning equipment used in boiler sections with temperatures below the ash-softening temperature.

1 The same quantity of shot will clean the entire vertical section with no limitations to the height.

2 Boiler height may be reduced by removing cavities normally required for conventional cleaning equipment.

3 The shot system requires no platforms or galleries around the boiler as does the conventional cleaning equipment.

4 The use of shot cleaning may reduce the aisle space between boilers by omission of the conventional cleaning equipment.

5 The cleaning ability of the shot system is often superior to that of the conventional cleaning equipment.

There are 30 black-liquor recovery boilers being cleaned with a pressure-lift system or a hyperflow system in the United States. A light-phase system has been in operation at the Higgins Station of the Florida Power Corporation since the fall of 1955. Two more recent installations of the light-phase system are on the Philadelphia Electric Company boilers.

The experience gained on these initial installations has proved the desirability and feasibility of cleaning areas as described in this paper through the use of falling shot.

What Industry Wants From the Electric-Utility Industry. 58—A-204

By P. L. Richardson, Assoc. Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

What can electric utilities do to attract chemical or other industries into their territory?

Although there are many physical, economic, and intangible factors which determine where a new plant will be built, in this paper remarks are limited to the following considerations on the subject:

1 Combination supply of steam and electric services on a co-operative basis.

2 Importance of quality of electric service.

3 Rate consideration.

4 Utility effectiveness on site studies.

The utility industry should seek manufacturers that selectively fit the local conditions; take a long-range view on system design and improvements to continually up-grade service quality; seriously consider the advisability of offering related utility commodities; establish fair tariffs and respect confidences.

Loss and Stall Analysis of Compressor Cascades. . . . . 58—A-91

By Seymour Lieblein, Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A simple equation expressing the wake momentum thickness as a primary function of the suction-surface diffusion ratio (ratio of maximum surface velocity to outlet velocity) of conventional low-speed cascade blades is derived from

boundary-layer theory in conjunction with simplifying approximations. The derived equation is utilized to gain an insight into qualitative effects on stalling diffusion ratio of such factors as Reynolds number, transition location, and extent of local laminar separation. Use of parameters suggested by the analysis is shown to result in generalized experimental loss and stall correlations and in means for estimating total-pressure loss and unstalled range of operation for commonly used blades.

The Unique Delaware Power & Light-Tidewater Agreement.....58—A-271

By F. P. Hyer, Delaware Power & Light Company, Wilmington, Del. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

During recent years several utility companies have made agreements with other industries to supply their steam and electrical requirements from power plants constructed adjacent to industrial sites. This has long been the practice on the Pacific and Gulf Coasts where the petroleum industry has contracts with utility companies for steam and electric-power service.

In 1955, Delaware Power & Light Company contracted with Tidewater Oil Company to build and operate a power plant adjacent to Tidewater's Delaware Flying "A" Refinery site to supply this refinery with steam and electricity.

The contract also calls for operation and maintenance of the water-treatment plant which supplies both the refinery and the power plant. Tidewater owns the water-treatment plant and leases it to Delaware Power & Light.

The principal provisions of the agreement are outlined and include the design of the power plant, water supply, fuel, transmission-line facilities, charges for electric service and purchase of surplus electricity, and such.

Significant plant facilities are described briefly; comments on certain problems encountered during the first year's operation are also included.

Hydraulics

Applications of Computer and Model Studies to Problems Involving Hydraulic Transients.....58—A-101

By I. W. Mc Caig and F. H. Jonker, H. G. Acres & Company, Ltd., Niagara Falls, Canada. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

For the economic design of large hydroelectric projects the applications of water-hammer and surge-tank stability theory have had to be extended and the increased volume of computational work has required the employment of digital and analog computers. In some cases when the exact form of differential equation for the hydraulic transient is not known, resort has been made to experiments on dynamically similar models.

This paper deals, first, with the application of a digital computer to water-hammer calculations on a complicated penstock layout.

It then shows how problems dealing with the stability of a surge tank can, in many cases, be clarified by the use of an analog computer and, in cases where extremely variable hydraulic losses unduly complicate the hydraulic transients, an electronically controlled model may be used to effect economies in surge-tank costs.

Some Hydraulic Features of Puntledge Generating Plant.58—A-100

By A. W. Lash, British Columbia Power Commission, Victoria, B. C.; and R. E. Passmore, Canadian Allis-Chalmers, Ltd., Montreal, Que., Canada. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

Puntledge Generating Plant has an exceptionally long penstock in relation to head, and pressure fluctuations are limited by means of an automatic pressure regulator. The automatic and remote-control features of the plant are described in relation to this equipment. In Part I the reasons for the design adopted are outlined, and the testing and control features are described. In Part II a detailed description is given of the pressure-regulator design and construction.

An Analysis of Axial Compressor Cascade Aerodynamics, Part I....58—A-83

By G. L. Mellor, Princeton University, Princeton, N. J. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A method is presented whereby complete potential-flow solutions for any cascade geometry may be obtained with comparatively great rapidity on desk calculators. This solution is carried out for the case of symmetrically cambered airfoils such as the 65-series compressor and circular arc airfoils, and the results presented in a compact graphical form completely account for the potential-flow effects of camber, profile thickness, stagger, solidity, and angle of attack. Real fluid effects will be assessed and correlated in Part II using the present results as a supporting theory.

An Analysis of Axial Compressor Cascade Aerodynamics, Part II....58—A-84

By G. L. Mellor, Princeton University, Princeton, N. J. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

The theoretical potential-flow results of Part I are compared with the large number of NACA 65-series compressor blade data. It is found that a single empirical constant used to modify the theory permits reasonable predictions of turning or lift coefficient to be made for any cascade geometry in the unstalled regions of flow. Furthermore, it is demonstrated that the theory allows a considerable number of plus and minus stalling angle of attack data to be collapsed to a single empirical curve. Conversely such a curve, once established, allows stalling predictions to be made for any cascade geometry. One interesting point on this curve is the loading limit above which the cascade is always stalled.

Résumé of the Supersonic-Compressor Research at NACA Lewis Laboratory.....58—A-177

By W. W. Wilcox, E. R. Tysl, and M. J. Hartmann, National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

Each phase of the supersonic-compressor program conducted at the NACA Lewis Laboratory is reviewed with a discussion of the objectives and results of the various experiments and associated analyses. Particular emphasis is placed on the state of development at the time the work was done, the advancement resulting due to this program, and the association of the several phases of the research program. The assembling of all the reference material of this program serves as a background for further work in the area of supersonic compressors or related fields.

Included in this paper are a few comments on the results of the supersonic-compressor research program and a mention of possible future applications.

Reversible Pump-Turbines for Sir Adam Beck-Niagara Pumping-Generating Station.....58—A-108

By P. Deriaz, The English Electric Company, Ltd., Rugby, England; and J. G. Warnock, English Electric Canada, a division of John Inglis Company, Ltd., Toronto, Ont., Canada. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The new reversible pump-turbines installed at Sir Adam Beck Pumping-Generating Station of the Hydro-Electric Power Commission of Ontario are described. The new machine is derived from developments in high-head variable pitch, turbine runners.

Runner-speed considerations, guide vane and runner-blade operating angles, hydraulic model tests, and mechanical laboratory tests are discussed. Special problems of design, the shaft gland, self-lubricating bearing, runner blades and operating mechanisms, and connections to the governor are also treated.

Transitional Phenomena in Ultrasonic Shock Waves Emitted by Cavitation on Hydrofoils...58—A-117

By F. Numachi, Mem. ASME, Tohoku University, Sendai, Japan. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

In some cases during the experiments described in past reports which dealt with cavitation-induced ultrasonic shock waves, extremely anomalous values were obtained in the imparted pressure of the shock waves. The paper deals with an investigation into the nature of these shock-wave anomalies, and it is demonstrated that these anomalies can be caused not only in closed-circuit cavitation tunnels but can be produced in any flow subjected to preliminary cavitation at a point upstream of the point of principal cavitation. The nature of the anomalies occurring in the shock-wave spectrum was studied, and its relation to cavitation-bubble size was made clear.

Centrifugal Manometer.58—A-111

By J. F. Kemp, South African Council for Scientific and Industrial Research, Pretoria, South Africa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The operating principles and mechanical construction of a micromanometer, which utilizes air instead of a liquid as working fluid, are described. Some of the noteworthy features of the instrument include its high sensitivity and accuracy, quick response, wide range, and ease of manipulation. Differential pressures of the order of 5×10^{-3}-mm water gage can be measured with an error of 1 per cent under normal laboratory conditions. The maximum range of the prototype described is 25-mm water gage, and the corresponding error at this value amounts to about 0.25 per cent.

A Survey of Stall Propagation—Experiment and Theory.58—A-150

By H. W. Emmons, Mem. ASME, and R. E. Kronauer, Harvard University, Cambridge, Mass.; and J. A. Rockett, Pratt and Whitney Aircraft, Cambridge, Mass. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The experimental literature on stall propagation is summarized in terms of an idealized compressor which possesses properties typical of the bulk of published data. The published analyses are examined and all are shown to have one fundamental restriction or another which makes them unable to predict all of the relevant features of stall propagation—most notably the number of stall cells. A relatively simple mathematical model is constructed which offers the possibility of a complete prediction.

Instruments and Regulators

Static and Dynamic Control Characteristics of Flapper-Nozzle Valves .....58—A-160

By Tsun-Ying Feng, Bell Aircraft Corporation, Buffalo, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The flapper-nozzle valve has been used extensively as a first-stage valve in many two-stage electrohydraulic servo valves. It is comparatively simple in construction and relatively reliable in operation. However, this type of valve has inherent drawbacks because of metallurgical properties and flow characteristics. These drawbacks are tolerable to most present hydraulic servos. As the environmental conditions become increasingly severe, the effects may cause unacceptable servo performance. To improve or eliminate, if possible, these drawbacks, it is necessary to understand the basic characteristics of this type of control valve.

A basic study was conducted on a flapper-nozzle hydraulic control valve to explore in detail its static and dynamic control characteristics. These static and dynamic control characteristics are presented and both the theoretical and experimental results compared. Correlation between the theoretical and experimental results was found to be quite good.

The Response of Pneumatic Transmission Lines to Step Inputs..... .....58—A-136

By C. B. Schuder, Assoc. Mem. ASME, Fisher Governor Company, Marshalltown, Iowa; and R. C. Binder, Mem. ASME, Purdue University, Lafayette, Ind. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

An equation was derived which describes the pressure-time relationship that occurs at the end of a dead-ended or volume-terminated pneumatic transmission line following a sudden pressure change at its input. The two partial differential equations which are solved are basic for transient fluid flow in pipes and analogous to the equations for transient electric current in lines without leakage.

The derivation was based on a one-dimensional uniformly distributed system, small, reversible, adiabatic-pressure changes, and laminar flow. Experimental results obtained from tests on $^3/_8$ in. and $^1/_4$-in. tubing showed good agreement with the theoretical results.

Application and Analysis of a Computer Control System..... .....58—A-281

By Irving Lefkowitz and D. P. Eckman, Case Institute of Technology, Cleveland, Ohio. 1958 ASME Annual Meeting paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The electronic computer offers the possibility of achieving complete and precise control of physical systems. An application of particular interest is the computer control of industrial processes to specified criteria of performance; e.g., control of the process such that product of uniform, specified quality is produced under conditions of minimum cost.

A computer-control application to a batch-type process is presented. The method of control, based on repetitive computer action and fast-time scaling makes it possible to obtain a specified end-point consistent with a prescribed criterion of optimum performance.

A method for approximate determination of system behavior based on pertur-

bation techniques is described. The study is augmented by data on computer control of a three-component-batch chemical process. The results of the dynamic analysis are compared qualitatively with the experimental results of predictor and optimizing control runs.

Building an Education Program in IRD.....58—A-233

By C. R. Otto, Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Proposals are made for additional activities which the IRD Education Committee might undertake. These scan the four areas of postcollege training, college education, precollege training, and communications with the general public.

Major emphasis is placed on aids to self-training of practicing engineers in the postcollege area. This group offers the maximum potential for most quickly developing greater numbers of better engineers. Illustrations center around new, specialized topics not yet common in colleges or extension courses, such as process control and computer utilization.

Programs suggested in other areas are mainly of a vocational-guidance nature. In all four areas, co-operative programs with other societies are preferable.

An Introduction to the Time-Modulated Acceleration Switching Electrohydraulic Servomechanism.....58—A-159

By S. A. Murtaugh, Jr., Cornell Aeronautical Laboratory, Buffalo, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A discussion of a new concept in electrohydraulic control is presented in this paper. The usual hydraulic servomechanism design uses a d-c amplifier and a flow-control servo valve to obtain hydraulic flow proportional to the position or velocity error of the load.

In the acceleration switching servo these components are replaced by an electronic multivibrator and an especially designed electrohydraulic servo valve, called an acceleration switching valve. System control is obtained through modulation of the multivibrator square-wave dwell time by which the driven-load acceleration is regulated. The servo valve behaves as a pure integrator throughout most of its operating frequency range.

Use of this technique has resulted in increased reliability, excellent servo-valve resolution, negligible center shift due to temperature extremes, and near infinite pressure-gain characteristics.

Statistical Optimization of Regulators Employing a Binary Error Criterion.....58—A-71

By J. H. Milsum, National Research Council of Canada, Ottawa, Ont., Canada. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

The problem is considered of minimizing total costs of a regulator subject to both a steady reference input and a statistical load disturbance. A binary error criterion is used which directly relates the error magnitude to the economic penalty entailed by the error. In contrast it is not easy to relate the mean-square error to economic penalty. Experimental work shows that the amplitude probability density distributions in saturating loops are altered sufficiently from the Gaussian, that the statistical linearization technique does not predict results with satisfactory accuracy in many cases of interest. The use of modified distributions alleviates this problem, but analog-computer experiments provide the most satisfactory attack for complicated situations and are easily instrumented.

Gas Turbine Power

Development of a Smooth Running, Double-Spool, Gas-Turbine Rotor System.....58—A-197

By J. R. Schnittger, Swedish Turbine Company Ljungstrom (STAL), Finspong, Sweden. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power*; available to Oct. 1, 1959).

Bearing stability difficulties of a 10,000-kw gas-turbine plant comprising three independent shafts (those of the low-pressure compressor, the high-pressure compressor, and the power-turbine rotors) are discussed. The bearing design changes which finally resulted in a solution of this instability problem are outlined, followed by a theoretical discussion of dynamic shaft and bearing performance which explains the experimental findings.

Flow-Induced Noise in Heat Exchangers.....58—A-103

By A. A. Putnam, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power*; available to Oct. 1, 1959).

Only rarely have noise generations, excessive pressure losses, tube failures, and wall buckling, all resulting from vortex shedding, constituted a severe problem in heat exchangers in the past. However, with the increasing emphasis on more compact heat exchangers and higher velocities in heat exchangers, the kinetic energy available for producing strong vorticity and overcoming damping losses is increasing. At the same time, cleaner designs are leading to a decrease in the relative acoustic-damping losses within heat exchangers. Thus the problems associated with vortex shedding can be expected to become more common and more acute.

It is the purpose of this paper to outline the general mechanisms by which this noise is generated and to present some examples in which difficulties have been caused by the vortex-shedding phenomenon. A future course of action in handling these problems is suggested.

A Simplified Regenerator Theory.....58—A-135

By W. F. Schalkwijk, N. V. Philips, Gloeilampenfabrieken, Eindhoven, Netherlands. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power*; available to Oct. 1, 1959).

Most regenerators encountered in practice have simple linear or exponential temperature fields in their central parts. This leads to the possibility of a simplified representation of the regenerator efficiency with sufficient accuracy for all practical cases. In the important "symmetrical" case, in which the parameters have the same value in both directions of gas flow, the efficiency can be represented by a single curve. This case is treated extensively in this paper. The results of the general case are given in an Appendix. Here also a reduction is achieved of the number of parameters needed to represent the efficiency.

M-252 Alloy for Heavy-Duty Gas-Turbine Buckets.....58—A-191

By G. R. Fusner, Mem. ASME, and D. L. Newhouse, General Electric Company, Schenectady, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power*; available to Oct. 1, 1959).

In 1954, when a turbine was being designed to operate with a turbine-inlet temperature of 1500 F and a corresponding first-stage bucket temperature of 1250 F, a number of superalloys were considered for the first-stage bucket

material. The most promising material was vacuum-melted M-252, which had been used successfully in aircraft gas turbines. When used in this type of service, the alloy operated at high temperatures for short periods of time, contrasted to the lower temperatures and long-time service required in heavy-duty machinery.

Most of the laboratory data on this alloy were obtained to determine its suitability as an aircraft gas-turbine material. However, the limited amount of data taken at 1200 F and the stress-rupture characteristics to approximately 1000 hr were encouraging. Since high reliability is required in heavy-duty gas turbines, a laboratory evaluation program was conducted on the alloy to make sure that it had the necessary properties. Tensile, rupture, creep, fatigue, damping, oxidation, and corrosion tests were performed. Many of these tests were made on specimens which had been aged for 5000 and 10,000 hr. Rupture data were obtained to 15,000 hr. Operating experience has confirmed laboratory tests, and now M-252 is destined to become a standard bucket material for heavy-duty gas turbines.

The Effect of Fuel Types and Admission Method Upon Combustion Efficiency.....58—A-128

By H. N. McManus, Jr., Assoc. Mem. ASME, Cornell University, Ithaca, N. Y.; W. E. Ibele, Assoc. Mem. ASME, and T. E. Murphy, University of Minnesota, Minneapolis, Minn. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A series of tests to determine the effect of combustion-chamber length for three different types of fuel admission (gaseous, spray, and vaporized) upon combustion efficiency was performed in identical combustor geometries and with similar air-flow patterns. The effects of fuel-air ratio and full-section velocity were examined for individual methods of admission. The effect of fuel volatility also was examined. It was found that the vaporized fuel type of admission was superior in efficiency to the spray-fuel admission in all comparable cases. Increased fuel volatility improved performance in the case of the vaporizer but did not affect the performance of the spray nozzle. The performance of vaporizing tubes was found to vary inversely with size. An optimum size was exhibited.

Railroads

A Review of Some Recent Advances in Lubrication of Railway-Car Journal Plain Bearings.....58—A-266

By R. F. Meeker and D. C. McGahey, The Texas Company, Beacon, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Worn-in railway-car journal bearings operating under normal conditions without defects and with an adequate supply of oil perform satisfactorily when lubricated with straight mineral oil of the proper viscosity. Tests conducted on full-scale laboratory equipment demonstrate that it is difficult to fail a bearing under these conditions simply by varying factors of load and speed. This is confirmed by the large numbers of bearings in actual service which operate without distress. Accordingly, if all bearings could be operated continuously under normal conditions with an adequate oil supply it would be unnecessary to improve on the intrinsic ability of straight mineral oils to maintain a satisfactory lubricating film.

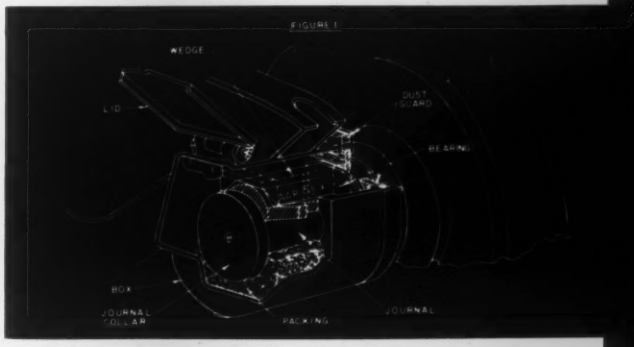
However, actual operating experience shows that ideal operating conditions do not always exist in railway service, since hotboxes do occur. Such factors as oil starvation, abnormal unit load, or low oil viscosity create conditions of boundary lubrication which all too frequently progress into bearing distress and failure —a hotbox. In such cases of boundary lubrication straight mineral oils have been demonstrated, both in the laboratory and in actual service, to be inadequate.

It is this fact which creates the necessity to improve on the lubricating qualities of straight mineral oil and to develop oils which exceed the physical requirements of AAR Specification M-906-56. Such oils provide a factor of safety not possible with straight mineral oil by sustaining higher unit loads resulting from improper load distribution, reducing coefficients of friction and bearing temperatures, and reducing metal displacement and wear. While it is recognized that many bearing failures are due to causes which are beyond the realm of prevention by lubricant quality, it is entirely reasonable to conclude that heavy-duty car oil incorporating the foregoing improvements can and do prevent an appreciable percentage of marginal conditions from progressing to costly hotboxes.

Investigation of the characteristics of various lubricator pads indicates that wicking rates are a function of oil viscosity and wicking media only and are independent of the type of base oil. Different types of pads wick oil at greatly different rates and none of the pads tested feeds oil as well as a typical waste-packed box. Wicking rates at winter temperatures are negligible, and no oil feeding occurs until the bearing and journal temperatures rise and raise the temperature of the oil. Consequently, specifications restricting low-temperature viscosity are unrealistic.

Seasonal grades of car oil are recommended for free oiling to compensate for increased oil viscosity and reduced wicking rates at low winter temperatures and to compensate for reduced oil viscosity and weakened fluid-film lubrication during high summer temperatures. High-quality, heavy-duty oils in the 45 SSU at 210 F range are recommended for winter use, while the same type of oil in the 85 SSU range is suggested for summer. When seasonal grades of car oil are used effectively, viscosity index loses much of its significance.

In summary, good maintenance and high-quality car oil are a combination which will do much to keep the hotbox situation under control. The service records of several railroads which believe the plain journal bearing can be made to operate successfully support this.



Railway freight-car journal plain bearing. This is typical of the 14,500,000 plain bearings on which the 1,825,000 freight cars currently in service on the American railroads move in their daily travels. (58—A-266)

bation techniques is described. The study is augmented by data on computer control of a three-component-batch chemical process. The results of the dynamic analysis are compared qualitatively with the experimental results of predictor and optimizing control runs.

Building an Education Program in IRD.....58—A-233

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Programs suggested in other areas are mainly of a vocational-guidance nature. In all four areas, co-operative programs with other societies are preferable.

An Introduction to the Time-Modulated Acceleration Switching Electrohydraulic Servomechanism.....58—A-159

By S. A. Murtaugh, Jr., Cornell Aeronautical Laboratory, Buffalo, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

A discussion of a new concept in electrohydraulic control is presented in this paper. The usual hydraulic servomechanism design uses a d-c amplifier and a flow-control servo valve to obtain hydraulic flow proportional to the position or velocity error of the load.

In the acceleration switching servo these components are replaced by an electronic multivibrator and an especially designed electrohydraulic servo valve, called an acceleration switching valve. System control is obtained through modulation of the multivibrator square-wave dwell time by which the driven-load acceleration is regulated. The servo valve behaves as a pure integrator throughout most of its operating frequency range.

Use of this technique has resulted in increased reliability, excellent servo-valve resolution, negligible center shift due to temperature extremes, and near infinite pressure-gain characteristics.

Statistical Optimization of Regulators Employing a Binary Error Criterion.....58—A-71

By J. H. Milsum, National Research Council of Canada, Ottawa, Ont., Canada. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

The problem is considered of minimizing total costs of a regulator subject to both a steady reference input and a statistical load disturbance. A binary error criterion is used which directly relates the error magnitude to the economic penalty entailed by the error. In contrast it is not easy to relate the mean-square error to economic penalty. Experimental work shows that the amplitude probability density distributions in saturating loops are altered sufficiently from the Gaussian, that the statistical linearization technique does not predict results with satisfactory accuracy in many cases of interest. The use of modified distributions alleviates this problem, but analog-computer experiments provide the most satisfactory attack for complicated situations and are easily instrumented.

Gas Turbine Power

Development of a Smooth Running, Double-Spool, Gas-Turbine Rotor System.....58—A-197

By J. R. Schnittger, Swedish Turbine Company Ljungström (STAL), Finspong, Sweden. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

Bearing stability difficulties of a 10,000-kw gas-turbine plant comprising three independent shafts (those of the low-pressure compressor, the high-pressure compressor, and the power-turbine rotors) are discussed. The bearing design changes which finally resulted in a solution of this instability problem are outlined, followed by a theoretical discussion of dynamic shaft and bearing performance which explains the experimental findings.

Flow-Induced Noise in Heat Exchangers.....58—A-103

By A. A. Putnam, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

Only rarely have noise generations, excessive pressure losses, tube failures, and wall buckling, all resulting from vortex shedding, constituted a severe problem in heat exchangers in the past. However, with the increasing emphasis on more compact heat exchangers and higher velocities in heat exchangers, the kinetic energy available for producing strong vorticity and overcoming damping losses is increasing. At the same time, cleaner designs are leading to a decrease in the relative acoustic-damping losses within heat exchangers. Thus the problems associated with vortex shedding can be expected to become more common and more acute.

It is the purpose of this paper to outline the general mechanisms by which this noise is generated and to present some examples in which difficulties have been caused by the vortex-shedding phenomenon. A future course of action in handling these problems is suggested.

A Simplified Regenerator Theory.....58—A-135

By W. F. Schalkwijk, N. V. Philips, Gloeilampenfabrieken, Eindhoven, Netherlands. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

Most regenerators encountered in practice have simple linear or exponential temperature fields in their central parts. This leads to the possibility of a simplified representation of the regenerator efficiency with sufficient accuracy for all practical cases. In the important "symmetrical" case, in which the parameters have the same value in both directions of gas flow, the efficiency can be represented by a single curve. This case is treated extensively in this paper. The results of the general case are given in an Appendix. Here also a reduction is achieved of the number of parameters needed to represent the efficiency.

M-252 Alloy for Heavy-Duty Gas-Turbine Buckets.....58—A-191

By G. R. Fusner, Mem. ASME, and D. L. Newhouse, General Electric Company, Schenectady, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

In 1954, when a turbine was being designed to operate with a turbine-inlet temperature of 1500 F and a corresponding first-stage bucket temperature of 1250 F, a number of superalloys were considered for the first-stage bucket

material. The most promising material was vacuum-melted M-252, which had been used successfully in aircraft gas turbines. When used in this type of service, the alloy operated at high temperatures for short periods of time, contrasted to the lower temperatures and long-time service required in heavy-duty machinery.

Most of the laboratory data on this alloy were obtained to determine its suitability as an aircraft gas-turbine material. However, the limited amount of data taken at 1200 F and the stress-rupture characteristics to approximately 1000 hr were encouraging. Since high reliability is required in heavy-duty gas turbines, a laboratory evaluation program was conducted on the alloy to make sure that it had the necessary properties. Tensile, rupture, creep, fatigue, damping, oxidation, and corrosion tests were performed. Many of these tests were made on specimens which had been aged for 5000 and 10,000 hr. Rupture data were obtained to 15,000 hr. Operating experience has confirmed laboratory tests, and now M-252 is destined to become a standard bucket material for heavy-duty gas turbines.

The Effect of Fuel Types and Admission Method Upon Combustion Efficiency.....58—A-128

By H. N. McManus, Jr., Assoc. Mem. ASME, Cornell University, Ithaca, N. Y.; W. E. Ibele, Assoc. Mem. ASME, and T. E. Murphy, University of Minnesota, Minneapolis, Minn. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A series of tests to determine the effect of combustion-chamber length for three different types of fuel admission (gaseous, spray, and vaporized) upon combustion efficiency was performed in identical combustor geometries and with similar air-flow patterns. The effects of fuel-air ratio and full-section velocity were examined for individual methods of admission. The effect of fuel volatility also was examined. It was found that the vaporized fuel type of admission was superior in efficiency to the spray-fuel admission in all comparable cases. Increased fuel volatility improved performance in the case of the vaporizer but did not affect the performance of the spray nozzle. The performance of vaporizing tubes was found to vary inversely with size. An optimum size was exhibited.

Railroads

A Review of Some Recent Advances in Lubrication of Railway-Car Journal Plain Bearings.....58—A-266

By R. F. Meeker and D. C. McGahey, The Texas Company, Beacon, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Worn-in railway-car journal bearings operating under normal conditions without defects and with an adequate supply of oil perform satisfactorily when lubricated with straight mineral oil of the proper viscosity. Tests conducted on full-scale laboratory equipment demonstrate that it is difficult to fail a bearing under these conditions simply by varying factors of load and speed. This is confirmed by the large numbers of bearings in actual service which operate without distress. Accordingly, if all bearings could be operated continuously under normal conditions with an adequate oil supply it would be unnecessary to improve on the intrinsic ability of straight mineral oils to maintain a satisfactory lubricating film.

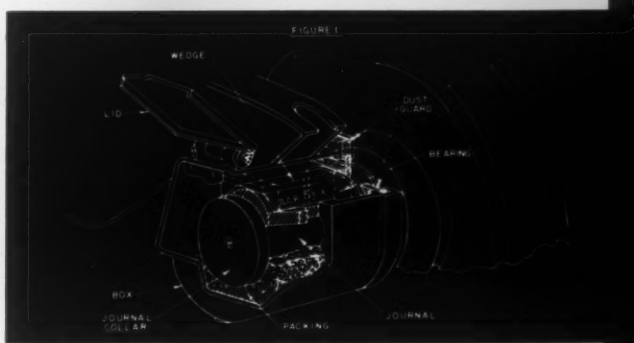
However, actual operating experience shows that ideal operating conditions do not always exist in railway service, since hotboxes do occur. Such factors as oil starvation, abnormal unit load, or low oil viscosity create conditions of boundary lubrication which all too frequently progress into bearing distress and failure —a hotbox. In such cases of boundary lubrication straight mineral oils have been demonstrated, both in the laboratory and in actual service, to be inadequate.

It is this fact which creates the necessity to improve on the lubricating qualities of straight mineral oil and to develop oils which exceed the physical requirements of AAR Specification M-906-56. Such oils provide a factor of safety not possible with straight mineral oil by sustaining higher unit loads resulting from improper load distribution, reducing coefficients of friction and bearing temperatures, and reducing metal displacement and wear. While it is recognized that many bearing failures are due to causes which are beyond the realm of prevention by lubricant quality, it is entirely reasonable to conclude that heavy-duty car oil incorporating the foregoing improvements can and do prevent an appreciable percentage of marginal conditions from progressing to costly hotboxes.

Investigation of the characteristics of various lubricator pads indicates that wicking rates are a function of oil viscosity and wicking media only and are independent of the type of base oil. Different types of pads wick oil at greatly different rates and none of the pads tested feeds oil as well as a typical waste-packed box. Wicking rates at winter temperatures are negligible, and no oil feeding occurs until the bearing and journal temperatures rise and raise the temperature of the oil. Consequently, specifications restricting low-temperature viscosity are unrealistic.

Seasonal grades of car oil are recommended for free oiling to compensate for increased oil viscosity and reduced wicking rates at low winter temperatures and to compensate for reduced oil viscosity and weakened fluid-film lubrication during high summer temperatures. High-quality, heavy-duty oils in the 45 SSU at 210 F range are recommended for winter use, while the same type of oil in the 85 SSU range is suggested for summer. When seasonal grades of car oil are used effectively, viscosity index loses much of its significance.

In summary, good maintenance and high-quality car oil are a combination which will do much to keep the hotbox situation under control. The service records of several railroads which believe the plain journal bearing can be made to operate successfully support this.



Railway freight-car journal plain bearing. This is typical of the 14,500,000 plain bearings on which the 1,825,000 freight cars currently in service on the American railroads move in their daily travels. (58—A-266)

Variables in Train Resistance..... .....58—A-265

By William M. Keller, Fellow ASME, Association of American Railroads, Chicago, Ill. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Train resistance has occupied engineers and railroad operating officials for many years. Formulas for train resistance have been in existence since 1855, and until 1938 many comprehensive reports were made on the subject. No recent reports, however, have been made to present a current and comprehensive analysis.

A study has been made of train resistance and the variables that are important in the determination of the horsepower requirements for the movement of railroad cars. Total train resistance has been represented by several investigators as a second-order polynomial with the train velocity as the independent variable.

The factors that influence train resistance are summarized as the journal-bearing friction, track resistance to rolling, wind resistance, curve and grade resistances, acceleration resistance, and starting resistance.

Each of these factors is examined for its magnitude of contribution to total train resistance.

The concepts of journal-bearing friction resistance and of track resistance as contributing elements are examined in their relationship to total resistance. Explanations of the various resistances are given in the light of bearing performance considerations and of the developments that have occurred in roadbed, track, and motive power during the years.

Aviation

Thermodynamic Considerations of Metal Containing Fuels For Jet Aircraft.....58—A-261

By J. R. Branstetter, Lewis Research Center, NASA, Cleveland, Ohio. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Despite the vast evolution that has taken place in the aircraft industry, the source of their power, petroleum, has remained unchanged. Petroleum is nearly ideal as an all-around fuel. Besides being plentiful, petroleum stores easily, burns at a very desirable rate for many applications, liberates a large amount of energy (both per unit volume and per unit mass), and the combustion products are normally gases. Notwithstanding the merit of our present fuels, attention is being focused on other chemical-energy sources for special purposes. The principal reason for this interest is that our military aircraft must match, or preferably excel, their competition in over-all performance. Over-all performance covers a multitude of items including range, speed, altitude capability, and maneuverability. The first item, range, is close to the top of the list in importance. Jet engines are notorious for their high fuel consumptions; therefore for maximum range it is desirable to pack as much energy content into each pound of fuel as is possible

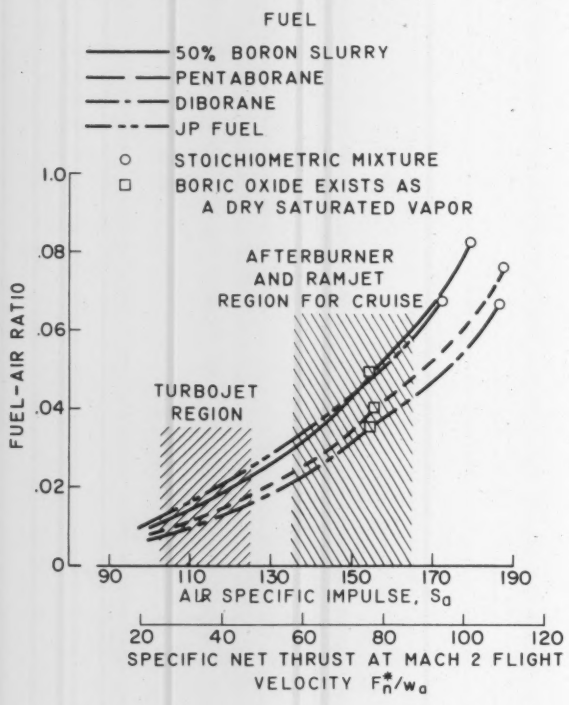
Fuel density plays a somewhat lesser part in that a less dense fuel requires larger tankage, increasing the aircraft volume, structural weight, and the aircraft drag; however, complete analyses of the aircraft and its mission are required to determine the exact relation between range and fuel density.

Some fuels yield greater flame temperatures and hence higher thrust capability than petroleum fuels. This property can be used to lessen take-off distance or improve flight maneuverability. A fuel having high thrust capability provides the aircraft designer with the option of reducing engine size, but a note of caution is appropriate; specific fuel consumption is usually more important than engine weight when maximum range is the primary consideration. Optimum cruise temperatures for both subsonic and supersonic aircraft can be obtained with petroleum fuels as well as other types of chemical fuels.

At high altitudes, and large angles of attack, engines often encounter combustion inefficiency and flame instability (flameout) when burning petroleum fuels. These problems would be eliminated by use of a highly reactive fuel (that is, a fuel that will burn well under severe conditions). Fortunately, most of the fuels under consideration possess greater reactivity than petroleum fuels.

The substitution of selected metal base fuels for JP fuel during part or all of a flight mission can yield significant improvement in aircraft performance. Magnesium slurries provide a practical means of producing very high air specific thrust; however, these slurries have a lower heat of combustion and therefore a higher specific fuel consumption than does JP fuel alone. Boron containing fuels are of interest because of their po-

Performance data for several boron-containing fuels (58—A-261)



tential to greatly extend flight range which stems from their high heat of combustion. The boron hydrides in particular, provide the combination of low fuel consumption and high chemical reactivity so desirable for long-range, high-altitude flight. The fuel savings afforded by diborane and pentaborane in the turbojet region amount to 39 and 31 per cent, respectively.

At afterburning and ramjet temperature levels (an air specific impulse of about 135 sec), the fuel consumption savings on a weight basis amounts to 34 and 27 per cent for diborane and pentaborane, respectively. At higher thrust levels, the boron fuels are penalized by the vaporization of the boric oxide. Unfortunately, the accuracy of engine performance calculations for boron-containing fuels is clouded by a number of factors, several of which are: (*a*) the accuracy of the thermodynamic properties of the combustion products and (*b*) the kinetics of boric oxide condensation. Boric oxide also presents a serious deposition problem. Work is in progress toward a successful solution to these problems.

A Note on Propulsion Efficiency.. .....58—A-245

By G. M. Dusinberre, Fellow ASME, The Pennsylvania State University, University Park, Pa. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

In the case of either a jet engine or an engine-propeller unit, one can measure a thrust horsepower and a fuel rate. By the use of the heating value of the fuel, the ratio can be expressed as an over-all thermal efficiency.

But in the case of the engine-propeller combination one can measure an additional item, namely, the engine shaft horsepower. This permits the definition of two additional ratios—a propulsion efficiency and an engine thermal efficiency. When these are multiplied together the shaft horsepower cancels out, giving the over-all thermal efficiency.

If it is useful to define and compare the corresponding efficiencies for the jet engine, it is necessary to define a term corresponding to the engine shaft horsepower, which does not exist as such in the jet plant. Let us call this the mechanical output of the engine.

In the case of an unchoked jet nozzle there is little argument about the logical figure to use. It is simply the increase of kinetic energy between the entrance and exist conditions. But what about a choked nozzle with a difference of pressure between exit plane and ambient? This pressure difference contributes to the useful thrust.

In this paper an expression is derived which offers an answer to this question.

Thermal Stresses in Missile Nose Cones.....58—A-274

By R. M. Christensen, Yale University, New Haven, Conn. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The aim of this study is to determine the stress distribution in a missile nose cone caused by an axially symmetric temperature and pressure distribution. The present analysis is limited to the elastic range, but it may be extended to consider plastic deformation and creep, as may become necessary for some materials. This is thought to be a reasonable assumption for certain of the ground-to-air missiles where the temperatures encountered are not sufficiently high to greatly alter the mechanical properties of the material.

The nose cones considered are those in the form of a surface of revolution. The temperature distributions which vary exponentially through the thickness can be represented as the sum of a temperature distribution which varies linearly through the thickness and a self-balancing temperature distribution. The linear temperature distribution is selected such that the difference between it and the actual temperature distribution is the self-balancing temperature distribution which produces neither moment nor axial force on the section. Since the self-balancing portion contributes only a local stress condition, it need not be included in the equilibrium solution. For purposes of description, the linearly varying temperature can be thought of as being composed of an average temperature T_{AVG} plus a linear distribution ΔT which causes hydrostatic bending only. That is to say, ΔT causes a linear distribution or normal stresses which will be indicated as hydrostatic.

As the first approximation, a membrane solution is considered. This is done by determining the membrane displacements from the general equations of equilibrium. The unknown moment terms in these general equations are taken as those caused by the hydrostatic bending moment, thus converting the general equations to membrane equations. Upon obtaining the solution for the membrane displacements, the corrective bending moments and, subsequently, stresses caused by these displacements can be computed, thus checking the validity of the membrane behavior assumption. If the bending action is found to contribute a considerable stiffness, then the solution can be iterated by taking the moment terms in the general equilibrium equations as those caused by the corrective bending moments, and then determining the second approximation for the membrane displacements. This process can be continued until the corrective bending moments from the last solution are negligibly small. Even for comparatively thick shells, this iteration technique would appear to be a more practical approach than attempting to solve the general equilibrium equations in one step.

The final stress distribution on the nose cone will be found from the superposition of the following four individual sources of stress:

1 Membrane stresses, which are the uniform stresses across the section caused by the membrane displacements and the temperatures T_{AVG}.

2 Hydrostatic bending stresses caused by temperature distribution ΔT.

3 Corrective bending stresses as found from the membrane solution displacements.

4 Self-balancing stresses which are caused by the difference between the actual temperature distribution and the linear variation used in the membrane solution.

Considered in this paper is a typical hemispherical nose cone with temperatures up to 3000F. Although the mechanical properties of the material are somewhat altered at this temperature, they are considered as remaining constant.

The aft edge of the nose cone is considered to remain free, even though it is actually constrained in some manner. The constraint of the aft edge may produce considerable stresses. However, they are of a local character and can be determined from a separate solution.

Characteristics of a Self-Lubricated Stepped Thrust Pad of Infinite Width With Compressible Lubricant..... .....58—A-194

By Kikuo C. Kochi, North American Aviation, Inc., Downey, Calif. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

Harrison's equation for the pressure in a gas-lubricated bearing of infinite width is solved for a thrust pad with stepped configuration. Analytic expressions for the pressure and load are developed. Numerical results are presented graphically. The analytic expressions together with the numerical data permit most of those characteristics of the stepped pad of practical interest to be completely determinable. Determination of optimum design parameters is given by a pair of graphs.

Safety

Human Factors in Machine Design .....58—A-280

By D. B. Learner, General Motors Corporation, Warren, Mich. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Recent years have seen an increasing volume of literature relevant to a field called, variously, engineering psychology, human engineering, or human-factors research. The objective of this discipline is to optimize the relationship of the man-machine system with regard to some criteria of performance.

The human-factors viewpoint adopts a systems approach—there is a job to be done and it must be accomplished within certain constraints by some combination of man and machines. No mention is made of the kind of tools, the extent of automation, or the kind of people who will do the job. This nonhardware approach is perhaps the focus of a system-oriented human-factors viewpoint.

Many of the more conventional equipment design procedures take such factors as safety, efficiency, material flow, manpower resources, and so forth, into consideration during design development. The fundamental advantage of the systems approach is that these factors are integrated into a logical step-by-step procedure in such a way that the final system represents an optimum combination of all of these factors. As an illustration, imagine a new product for which fabrication and/or assembly equipment must be designed and built. What are the steps that must be completed for the design of the optimum man-machine system?

Initially the goals of the system must be defined clearly. What is the system to accomplish? With what accuracy? How many units must be produced? How long should this take?

Once the goals of the system have been defined and the system requirements related to these goals, the system should be described in terms of the functions that must be performed in order to achieve these requirements. It is important to caution that this functional analysis is related to system requirements not to equipment that may be available.

At the outset, concern is with a general statement of what functions must be accomplished. It is necessary to determine how these functions will be performed, and information concerning the capabilities and limitations of both men and machines is needed. The allocation of functions to men or machines is needed. The allocation of functions to men or machines may best be accomplished on the basis of those functions which either system component can perform most ably.

Functional allocation of tasks should be charted to depict the flow of jobs and processes in order to verify the logical relationship that may exist from the beginning to the end of the manufacturing process. In the event that inconsistencies arise, a reallocation of functions or a redetermination of system requirements is necessary. The flow charts along with state-of-the-art engineering data and human capabilities data form a sound foundation for the specific machine or process-design tasks.

Following completion of the functional allocation, specific descriptions of the operators' tasks should be prepared. Using the work-load analysis as a criterion, it is possible to determine the number of operators that are required to complete the process. Work stations and work-space layout evolve from the load analysis.

The final analytic predesign step is to determine, on the basis of the task requirements, what information and responses each operator will utilize in order to perform his function in the system. The ideal situation requires that the operators have sufficient information about the process to control it—no more, no less.

Specific design tasks must progress parallel with the system development. For example, as the functions are allocated to operators or machines the necessary machine designs to accomplish these functions may be initiated.

Petroleum

Storage-Tank Design Practices to Avoid Brittle Fracture..58—A-149

By J. S. Clarke, Mem. ASME, and T. F. Leahey, Esso Research and Engineering Company, Elizabeth, N. J. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Within the range of service conditions under which steel storage tanks frequently operate, and particularly where atmospheric temperatures are below 50 to 60 F, complete failure can occur under applied principal stresses well below generally employed design values. Such failures are much more apt to occur in welded than in riveted tanks and in large tanks than in small tanks.

As a result of two such failures occurring at Fawley, England, within a period of six weeks in 1952, the Esso Research and Engineering Company carried out a study and experimental program to determine the mechanism of this type of failure and means of preventing similar failures in the future. This paper presents the design and construction practices for refinery tankage which have been established to avoid brittle fracture. The program and results obtained have been presented in the public interest in various earlier papers and are discussed herein only to the extent necessary to give reasons for establishing the practices described.

Design and Analysis of Welded Pressure-Vessel Skirt Supports.... .....58—A-153

By N. A. Weil, Mem. ASME, and J. J. Murphy, Mem. ASME, The M. W. Kellogg Company, New York, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.*; available to Oct. 1, 1959).

Factors determining the performance of welded skirt supports for vertical process vessels are discussed. The importance of thermal effects is emphasized. A comprehensive analysis of local stresses with closed-form solutions is presented, permitting assessment of expected performance in service on a fatigue basis. The expected shape of skirt distortions is briefly mentioned. Suggestions and recommendations are made for design practice, control of thermal stresses, weld, and fabrication detail for optimum practical quality, as dictated by service conditions. A numerical example is presented to illustrate the application of the analysis.

Hazards Associated With the Storage of LPG.....58—A-151

By R. B. Jacobs and F. A. Upson, Standard Oil Company (Indiana), Whiting, Ind. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The petroleum industry has long recognized that certain risks are involved in the storage of liquefied petroleum gases. However, those most commonly considered have been largely those associated with possible ruptures of containing vessels, fires, or combinations thereof.

The disastrous propane storage-vessel explosion at Whiting on January 29, 1957, highlighted a different kind of hazard; namely, the possibility of explosive mixtures existing in the vapor spaces of pressure storage containers. The present paper is principally concerned with defining the limits of this explosive hazard and discussing the engineering problems associated with it.

Process Industries

Atmospheric Gas-Fired Infrared Heaters for Processing Applications.....58—A-210

By Marc Resek, Mem. ASME, Shaker Heights, Ohio. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Infrared radiation provides a means for transferring heat from a source to a point where it is needed without heating the intervening air and without any transfer medium.

A gas-fired burner operating under atmospheric pressure has been developed as an efficient source of radiation.

This generator was invented in Germany by Gunther Schwank and is now being manufactured and sold in America.

Gas enters the burner under line pressure through an orifice, and all air required for combustion is inspirated into a venturi tube by the gas. The mixture of gas and air enters a chamber, one face of which is covered by a ceramic plate having a large number of small holes which serve as ports for the gas-air mixture, which burns on the surface of the plate, which is about $^3/_8$ in. thick, made of material having very low thermal conductivity, and with a large percentage of its area forming the ports. A natural-gas burner has 7200 holes 0.055 in. diam in a surface of 39 sq in.

The large port area results in low back pressure in the burner which makes it possible to induce all air required for combustion as primary air. The low thermal conductivity of the ceramic plate reduces flow of heat from the red-hot burner face to the interior of the burner, eliminating danger of backfiring, and aiding in maintaining a high surface temperature. The ceramic surface is of a composition having a high-infrared emissivity.

Individual burners of this type have an input of about 12,000 Btu per hr or 44,750 Btu per hr per sq ft of radiant surface. They are made to burn natural, manufactured or LP gases, the same burner handling either natural gas or propane by changing the orifice, whereas manufactured gas requires a different port size as well as a larger orifice.

The catalytic effect of the heated ceramic surface with a correctly proportioned gas-air mixture results in a surface combustion. The temperature of the ceramic surface can be increased further by the use of an open-mesh metal screen about $^1/_4$ in. from the surface, so that combustion takes place between the ceramic and the screen.

The efficiency of conversion of the heat of combustion to infrared radiation depends on the surface condition and temperature. At 1650 F, the Schwank burner has an efficiency in the neighborhood of 60 per cent.

Heaters having burners of this kind are especially useful for warming buildings of the type frequently utilized for industrial processing. This burner is also employed in the processing field for many other purposes; for example, to thaw frozen cars of coal or ore, to heat dies, molds and cores, to bake finishes, to dry materials, to control humidity or to supply process heat. Some of these uses are illustrated. It is expected that many additional applications for infrared radiation will be found as industries have further experience with this method of heating.

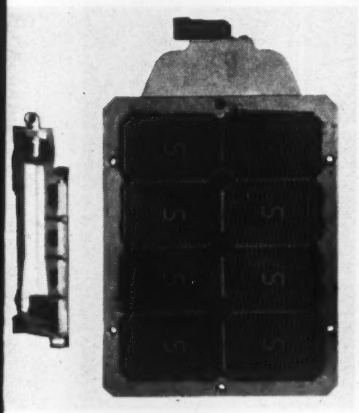
Power Heat Balance Considerations in Design and Operation of Industrial Plants.....58—A-166

By J. I. Hudson, Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.*; available to Oct. 1, 1959).

The performance of a manufacturing enterprise often is measured in terms of return on investment. Many factors have a bearing on performance but two of the most significant ones are investment cost and operating cost. In this paper the design and operation of "power-service" facilities for industrial plants are considered in relation to the problem of minimizing over-all plant investment and operating cost.

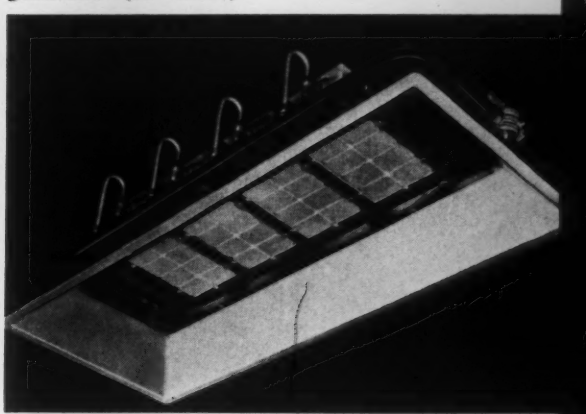
The term power services refers to steam, electricity, refrigeration, compressed air, water of different qualities, and other utilities supplied by modern industrial power plants.

Often it is profitable to accept an increase in investment or manufacturing



Schwank gas-fired infrared generator. Inset shows section through furnaces. (58—A-210)

Infrared heaters prevent rusting of steel in storage (58—A-210)



Overhead radiant space heater with four Schwank generators (58—A-210)

cost in one area to obtain a cost reduction or an advantage of greater magnitude in another area. For instance, the higher cost per Btu of electricity as compared with other heat sources can be justified in certain industrial-furnace applications because of lower investment cost and improvements in product quality.

Relations between design of process equipment and power-service facilities for industrial plants and the effect of each on over-all investment and operating costs are shown by typical examples. A brief discussion is given of a method of controlling manufacturing costs by application of power-performance standards, once a plant is in operation.

Air Conditioning for the New Social Security Building . . . . . 58—A-276

By K. W. Malach, Mem. ASME, Whitman, Requardt and Associates, Baltimore, Md. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The new Social Security Building will house all the administrative and operational functions of the Bureau of Old Age and Survivors Insurance of the Department of Health, Welfare and Education of the United States Government.

The new building is in three main sections, all interconnected. These are the Administration wing, the operations wing, and the link (connecting the administration and operations wings). Included in the building are a Library, a one-story 1200-seating-capacity cafeteria, a kitchen adjacent to the cafeteria with food-preparation facilities for 6000 noontime meals, and a 500-seating-capacity auditorium adjacent to the cafeteria.

The compressor room is in the basement below the link, and the boiler room is in the basement level below the west half of the administration building. The total floor area of the project is approximately 1,300,000 sq ft; the net usable area (after deducting toilet rooms, equipment rooms, compressor room, boiler room, stairs, elevators, and so on) is approximately 1,000,000 sq ft. All the net usable area is air conditioned.

For the air conditioning of the building, the inside design conditions used were 78 F dry bulb, 45 per cent RH for all spaces except the electronic-data-processing-machines (EDPM) area which was designed for 75 F dry bulb, 50 per cent RH. Outside design conditions used were 95 F dry bulb, 78 F wet bulb, which is the ASHAE standard for the Baltimore area. The selection of the cooling towers for condenser water was based on 97 F water to the towers and 80 F entering air wet-bulb temperature.

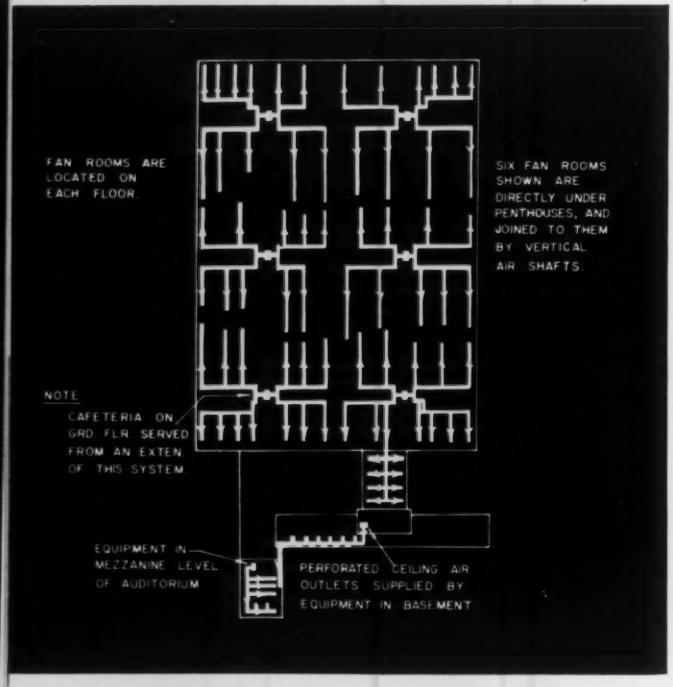
There are 34 air-handling units supplying 827,900 cfm of conditioned air into the various parts of the building. Of this total, seven units deliver 107,400 cfm of high-pressure air to under-the-window induction units at the perimeter of the administration wing, the link, and the operations wing. The remaining 27 units deliver air into conventional low-pressure ductwork and diffusers (or in some cases, perforated ceiling pans or grilles with volume control) to serve the interior spaces of the operations wing and link, the cafeteria, the auditorium, the EDPM area, and miscellaneous areas.

The locations of low-pressure, air-handling equipment rooms, penthouses, and pipe tunnels are so correlated as to result in a minimum amount of pipe and ductwork.

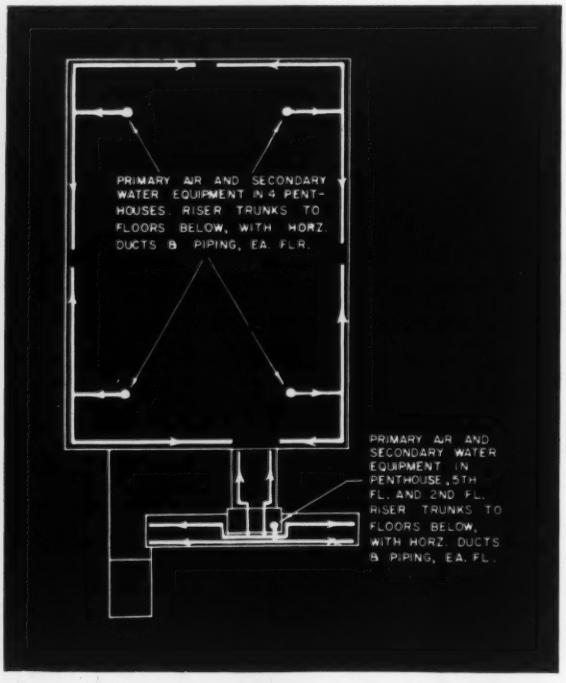
In addition to a general description of the air-conditioning system, the paper gives details of the low-pressure interior system and the high-pressure perimeter system.

The systems in operation for the EDPM area are also described in considerable detail.

Air conditioning the new Social Security Building. Twenty-two pressure-handling units are located in six interior locations. Low-pressure air-handling units are all arranged to handle a varying amount of outside air from a set minimum to 100 per cent. (58—A-276)


FAN ROOMS ARE LOCATED ON EACH FLOOR
SIX FAN ROOMS SHOWN ARE DIRECTLY UNDER PENTHOUSES, AND JOINED TO THEM BY VERTICAL AIR SHAFTS.
NOTE
CAFETERIA ON GRD. FLR. SERVED FROM AN EXTEN. OF THIS SYSTEM
EQUIPMENT IN MEZZANINE LEVEL OF AUDITORIUM
PERFORATED CEILING AIR OUTLETS SUPPLIED BY EQUIPMENT IN BASEMENT

Perimeter system uses high-pressure air. Major factor determining design of high-pressure ductwork was arrangement of columns and windows in exterior walls. Glass runs continuously between columns; there is no space for vertical pipes and ducts. (58—A-276)


PRIMARY AIR AND SECONDARY WATER EQUIPMENT IN 4 PENTHOUSES. RISER TRUNKS TO FLOORS BELOW, WITH HORZ. DUCTS & PIPING, EA. FLR.
PRIMARY AIR AND SECONDARY WATER EQUIPMENT IN PENTHOUSE, 5TH FL. AND 2ND FL. RISER TRUNKS TO FLOORS BELOW, WITH HORZ. DUCTS & PIPING, EA. FL.

Influence of Hot and Cold Storage-Loads on the Refrigerated-Space Temperature of a Cooling Complex .....58—A-165

By C. F. Kayan, Mem. ASME, Columbia University, New York, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.*; available to Oct. 1, 1959).

Of particular interest in cold-storage warehouse operations is the influence on the space-temperature-time history of a "hot" load of goods suddenly introduced into the refrigerated zone of an insulated structure. The zone may be completely empty, or partially occupied by warehouse goods already down in temperature. Of further interest is the ultimate effect of the transient load on the performance of other components of the system, such as the connected space-cooling heat exchanger. In previous work in this realm by the author on the behavior of the over-all complex, the studies have included the various heat-exchange and machine energy-transport equipments of the system. Whereas in the earlier paper the transient effect was explored via calculation methods, in the study of the problem in this paper experimental simulation methods are employed entirely, using pilot process-prototype transient elements.

The Compacting Process—A Method of Particle Agglomeration .....58—A-228

By H. D. Vanderlip and G. J. Jennrich, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

In the chemical and allied industries it is often necessary to make rapid changes in processing techniques to meet the more rigid specifications demanded by the consumer. Recent years have seen an accelerated demand for particle size, shape, and quality control of granular products.

Whatever method was used to achieve product control of these materials, undesirable fines were the by-product of the process. There is no market for the fines and they require elaborate and unprofitable recovery techniques to make them commercially acceptable.

The compacting process is a method of upgrading fines by agglomeration. This is accomplished by passing the fines between smooth rolls that are capable of exerting pressures great enough to produce a solid ribbon with sufficient character and strength that the ribbon so formed can be granulated to the desired particle size.

Metals Engineering

The Distribution of Contact Pressures in the Rolling of Metals..... .....58—A-260

By C. W. Mac Gregor, Mem. ASME, Philadelphia, Pa.; and R. B. Palme, Western Electric Engineering Research Center, Hopewell Township, N. J. 1958 ASME Annual Meeting paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

A comparison is made between the experimentally determined contact-pressure distributions obtained on square bars and flat strips. The former showed double peaks in the pressure, one near entry and the other near the roll center line. A pressure peak is obtained near the center line only for strip rolling.

Two independent analyses were made. One allowed the double peak for the square bars to be predicted with fair accuracy from stress-strain data. The second, based on the local elastic deformation of the rolls, also showed the transition in pressure distributions from billet to strip rolling.

The Measurement of Dry Sliding Friction at Elevated Temperatures.. .....58—A-225

By D. E. Miller, Dole Valve Company, Morton Grove, Ill. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

In the fall of 1950, an experimental investigation of sliding friction was conducted under the joint sponsorship of ASME and Illinois Institute of Technology. The original objective of the study was to establish data applicable to metal-processing operations, such as rolling and wire drawing. To this end, it was planned to conduct experiments with several materials over a broad temperature range. Inconsistent and seemingly unusual behavior was observed in the first series of tests conducted at 300 F, however, and a substantial part of the program was thereafter concerned with attempts to discover the reasons for the variability of results. Subsequent testing was limited to one combination of materials, steel on steel, and two temperatures, 300 and 600 F. Normal loads and sliding velocities were varied over broad ranges in these experiments. The purpose of this paper is to describe the phenomena observed and present the reasons for the unusual behavior, as deduced during the study and in experiments performed by other investigators.

A comprehensive program of research on sliding friction had been in progress in Britain for several years at the time of the study. This work was largely of a fundamental nature, aimed at establishing the basic mechanisms of friction and wear. Moderate to very light loadings were employed in these studies, and relatively few experiments were conducted at elevated temperatures. It was hoped that, in addition to providing useful values of coefficient-of-friction, the experiments described in this paper would complement the other work by developing information on friction phenomena at elevated temperatures under very high unit pressures.

Multiaxial Creep Studies on Inconel at 1500 F.....58—A-193

By C. R. Kennedy and D. A. Douglas, Oak Ridge National Laboratory, Oak Ridge, Tenn.; and W. O. Harms, University of Tennessee, Knoxville, Tenn. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

Design engineers have become concerned with the effect of multiaxial stresses on the creep rate and on the rupture life of metals as the demands for higher performance have necessitated the use of higher operating temperatures. The goal of applied research in this field is the development of failure criteria based on properties measured in the conventional uniaxial tension creep test.

The most common laboratory methods for studying multiaxial stresses under creep conditions employ (*a*) capped pressurized tubes and (*b*) tubes under combined torsion and tension. In the former case the ratio of the two larger principal stresses is always approximately two to one and the third principal stress is negative. In the latter case the two nonzero principal stresses are always of opposite sign. The stress states in many design situations, however, are quite often different from those which occur under these rather specialized test conditions.

The purpose of the present investigation was to examine the effect of multiaxial stress states in creep under less specialized conditions than have been reported previously. The material used in the investigation was Inconel, a common high-temperature alloy of nominal composition 80Ni-15Cr-5Fe, and the tests were performed at 1500 F.

Comparison of Parameter Methods for Extrapolating High-Temperature Data.....58—A-121

By R. M. Goldhoff, General Electric Company, Schenectady, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

The use of the controversial and con-

tradictory parameter techniques in correlation of high-temperature stress-rupture data is discussed. They are treated with a view toward their application in extrapolating short-time data to predict working stresses in serviceable heat-resistant alloys.

Three parameter methods are compared on a statistical basis for their ability to reproduce the isothermal data on which they are based and in particular the longest time data currently available and usable for this purpose. Comparisons are further made with long-time extrapolations based on direct plotting of test data.

The materials chosen for evaluation are alloys S-590, A-286, Nimonic 80A, and 1Cr-1Mo-1/4V steel.

It is shown that prediction of long-time working stresses using parameter techniques will generally give better results than can be obtained from long extrapolations on double logarithmic plots. Among the parameters themselves, the Manson-Haferd linear parameter method gave the most reliable extrapolations. However, the results obtained using the Larson-Miller method may be improved considerably if the proper constant is selected for each set of data rather than using C = 20 for all data. For reliable extrapolations all methods require data from tests up to 1000 hr and covering adequate ranges of stress and temperature.

Correlation of High-Temperature Creep and Rupture Data.....58—A-96

By Hans Conrad, Westinghouse Electric Corporation, Pittsburgh, Pa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Oct. 1, 1959).

The problem of correlating high-temperature creep and rupture data has been considered in light of the most recent theoretical and experimental information. An evaluation of the equations most frequently employed indicates that they all possess one or more major shortcomings. An equation is proposed which is in better agreement with the experimental and theoretical information available. The rupture data for several superalloys and an aluminum alloy are correlated by means of the proposed equation. It is suggested that creep tests with incremental changes in the stress and temperature be investigated as a rapid method for evaluating the constants of the creep and rupture equations.

Heat Transfer

Heat Transfer to Water Coolant in Capillary Tubes for the Liquid, Mixed, and Vapor Phases.....58—A-234

By E. W. Schwartz, Assoc. Mem. ASME, Convair Division of General Dynamics Corporation, San Diego, Calif. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Stainless-steel capillary tubes, heated electrically, were employed to obtain local heat-transfer coefficients, based upon bulk fluid properties, with and without a coolant-phase change. The coolant was distilled water which was forced into the tubes; the internal diameters of the tubes were 0.007, 0.017, and 0.025 in. The coolant flowed from the exit section of any given tube to the atmosphere in the form of heated water, quality steam, or superheated steam, depending upon the heat flux and coolant flow rate.

Satisfactory correlations with the theoretical and empirical equations derived by Graetz, Drew, Hottel, and McAdams were obtained for heating of water flowing inside the capillary tubes at constant massflow rates. However, no correlation was observed with these equations when a coolant-phase change occurred within the tubes. For coolant phase-changing conditions, empirical correlations of local heat-transfer coefficients that included the liquid, mixed, and vapor phases of the coolant were obtained as functions of local coolant enthalpy, coolant mass velocity, and capillary diameter.

The Influence of Radiation on Convection in Noncircular Ducts.....58—A-155

By T. F. Irvine, Jr., University of Minnesota, Minneapolis, Minn. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Recent technological developments have fostered a renewed interest in heat-exchange equipment which is both compact and capable of operating at high-temperature levels. The gas turbine, rocket, and nuclear-power plants illustrate these interests with their associated heat-transfer problems of regenerator design and turbine blade and fuel-element cooling.

The requirements of compactness, along with other considerations, frequently dictate passage shapes which are noncircular in cross section. The absence of symmetry in such shapes literally adds a new dimension to the heat-transfer problem since in addition to changes in velocity and temperature occurring in the flow direction, appreciable variations in temperature and velocity distribution may be present around the periphery of the channel. Thus the designer of such equipment must be capable of predicting local temperatures and heat flows if he is to design intelligently for maximum heat transfer while not exceeding material limitations.

The influence of radiation in a noncircular duct cross section is discussed as a mechanism which alters the convective temperature boundary conditions and thus the average Nusselt number. An analysis of this effect is presented for the case of the infinite slot with different wall temperatures, and a numerical example illustrates that the neglect of the radiation effect leads to appreciable errors.

Laminar Heat Transfer in Rectangular Channels.....58—A-124

By L. S. Han, The Ohio State University, Columbus, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Heat Transfer;* available to Oct. 1, 1959).

Three cases of laminar heat transfer with linear heat input in long rectangular channels have been treated by the method of orthogonal trigonometric series. The boundary conditions of the first two problems are those of laminar and slug flows with two opposite faces as secondary extended surfaces. A new fin parameter has been shown to be the important factor in governing the Nusselt number. The third case discussed in the combined effects of free and forced-convection in vertical rectangular tubes.

The Calculations of Turbulent Skin Friction Around Blunt Bodies of Revolution at High Speed.....58—A-222

By P. K. Chang, The Catholic University of America, Washington, D. C. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

An analytical method for direct computation of the local compressible turbulent skin-friction coefficient with respect to the wetted surface of bodies is presented. Derivations of the friction-velocity law of compressible flow and the momentum thickness of a compressible turbulent boundary layer are included.

The present method is applicable for an arbitrary body of revolution at high speed and a fixed velocity profile parameter n. An integrated form of skin-friction coefficient, for a shape whose

local Mach number is independent of free Mach number ahead of detached shock wave, and a numerical calculation of skin-friction coefficient for a hemisphere, are presented. Local skin-friction coefficients are computed for the special case of an insulated surface, and a Prandtl number of unity. The computed skin-friction coefficient is in very good agreement with Van Driest's analysis for subsonic regions. Analytical values of c_f/c_{fi} are presented for the entire region of a hemispherical nose exposed to hypersonic flow.

Heat Transfer From Cylinders in Subsonic Flow.....58—A-202

By L. V. Baldwin, NASA, Lewis Research Center, Cleveland, Ohio. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

One thousand heat-transfer coefficients for normal cylinders in air were measured over the following range: Mach 0.05 to 0.80; Reynolds 1 to 75, Knudsen 0.009 to 0.077. Air temperatures between 460 and 740 R and cylinder temperatures between 493 and 1080 R were used. At $N_{Kn} = 0.009$, the measured Nusselt numbers agree quantitatively with extrapolated values from existing continuum flow empirical relations. The data qualitatively check predictions of free molecular flow theory at $N_{Kn} = 0.077$. Therefore the experimental slip-flow correlation serves as a partial bridge between continuum results and free-molecular theory. The heat-transfer coefficient h exhibits a complicated temperature dependence in slip flow; in contrast to continuum flow experiments h decreases with increasing cylinder temperature for $N_{Kn} > 0.02$. The Nusselt number variation with air temperature is also discussed.

Interferometric Investigation of the Stability of a Turbulent Boundary Layer With Mass Addition.....58—A-249

By D. S. Hacker, Assoc. Mem. ASME, The Illinois Institute of Technology, Chicago, Ill. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Transpiration cooling is a method devised to provide adequate protection for exposed structural members in high-speed flight. A coolant fluid is added normal to the boundary layer through a uniformly porous wall. The fluid thus serves a twofold purpose: (*a*) As a suitable heat sink within walls of structure; and (*b*) as a protective film along the surface, decreasing the effective heat-transfer coefficient. This work is concerned with the nature of the effect of the second fluid on the normally developed turbulent boundary layer.

Experiments were performed on a porous flat plate for the case of zero heat transfer and zero pressure gradient, using air as the working fluid. Measurements of the boundary-layer growth under conditions of mass transfer were made using a tracer gas, the refractivity of which differed enough that the gas could be detected by a Mach-Zehnder interferometer.

For the mass-addition rates examined the effects of diffusion transport of the diluent gas were negligible, thus minimizing any differences between the concentration and momentum thicknesses.

Velocity traverses and concentration traverses were compared with the interferometer values in the range of length Reynolds numbers investigated (10^4 to 10^6). The conditions for incipient separation or blowoff were determined from interferograms, and an equation relating the critical blowing parameter to the thickness Reynolds number was obtained.

A Theory of Rotating Condensation .....58—A-70

By E. M. Sparrow, Assoc. Mem. ASME, and J. L. Gregg, NASA, Lewis Research Center, Cleveland, Ohio. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Heat Transfer;* available to Oct. 1, 1959).

An analysis is made for film condensation on a rotating disk situated in a large body of pure saturated vapor.

The centrifugal field associated with the rotation sweeps the condensate outward along the disk surface, and gravity forces need not be involved. The problem is formulated as an exact solution of the complete Navier-Stokes and energy equations. Numerical solutions are obtained for Prandtl numbers between 0.003 and 100. Results are given for the heat transfer, as well as for the condensate layer thickness, torque moment, and temperature and velocity profiles.

The Effect of Surface Roughness on the Convection Heat-Transfer Coefficient for Fully Developed Turbulent Flow in Ducts With Uniform Heat Flux.....58—A-122

By R. T. Lancet, Mem. ASME, Los Angeles, Calif. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Heat Transfer;* available to Oct. 1, 1959).

In some industrial applications it becomes necessary to make heating or cooling ducts so small that the roughness resulting from normal manufacturing techniques becomes large with respect to the tube radius. In such cases the heat-transfer coefficient and pressure drop may increase appreciably over that for a smooth pipe. In still other cases, it might be desirable to provide a rough surface to increase the heat-transfer rate where space is more important to power loss as a result of increased pressure drop.

Experimental data are presented for the heat-transfer coefficient and friction factor in a smooth and a rough duct with a hydraulic diameter of approximately 0.035 in. The flow was fully developed and turbulent, and the heat addition was uniform over the length of the tube. The rough tube indicated appreciable increases in heat-transfer coefficient and friction factor. The smooth-tube friction factors corresponded to rough-tube values, indicating the difficulty involved in obtaining smooth surfaces for very small ducts.

The Emissivity and Absorptivity of Parachute Fabrics.....58—A-125

By J. P. Harnett, Assoc. Mem. ASME, E. R. G. Eckert, Mem. ASME, and R. Birkebak, University of Minnesota, Minneapolis, Minn. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Heat Transfer;* available to Oct. 1, 1959).

Use of parachutes for recovery of information and equipment from high-speed vehicles has directed attention to the heating problem which in some instances may be so severe as to cause destruction of the parachute. Consequently, the parachute engineer requires sufficient information on the heat-transfer characteristics of geometries resembling those of parachutes and on the heat-transfer properties of the materials used to allow a calculation of the temperature history of a descending parachute. In particular, the radiation properties of the parachute materials must be known since the parachute is receiving radiant energy from the sun and loses energy by radiation to the surroundings.

The measurement of radiation properties for such parachute materials is more complicated than for solid surfaces since an appreciable amount of energy is transmitted by such fabrics. It is the purpose of this paper to describe the equipment which was used to measure the absorptivity for solar radiation and the long-wave-length emissivity for such parachute materials and to report these data for a number of important parachute materials.

Applied Mechanics

A Theory for the Effect of Mean Stress on Fatigue of Metals Under Combined Torsion and Axial Load or Bending.....58—A-61

By W. N. Findley, Mem. ASME, Brown University, Providence, R. I. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

The concept that alternating shear stress is the primary cause of fatigue with the normal stress on the critical shear plane as an influencing factor has been developed for the case of mean (or static) stresses superimposed on combinations of torsion and axial load or bending. The influence of the maximum stress of the cycle of stress on the allowable alternating stress for a given number of cycles and on the orientation of the critical shear plane is explored. The predictions of the theory are consistent with the known trends of fatigue data both for ductile metals and cast irons. The theory explains the fact that the influence of mean stress is weak for torsion and stronger for bending of ductile metals, but strong for both torsion and bending of cast irons. As far as is known, this is the first rational theory for the influence of mean stress.

A Mathematical Model Depicting the Stress-Strain Diagram and the Hysteresis Loop.....58—A-68

By I. R. Whiteman, General Analysis Corporation, Los Angeles, Calif. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

A model is made up of elastoplastic elements, all of which have the same value of Young's modulus E, but which have different values of yield stress. It is shown that the dimensionless tangent modulus graph E_t/E represents the cumulative frequency distribution of those elements which are in the elastic region. From the frequency distribution, the equations for the stress-strain diagram and the hysteresis loop can be written.

Relief of Thermal Stresses Through Creep.....58—A-41

By H. Poritsky, Mem. ASME, and F. A. Fend, General Electric Company, Schenectady, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

Equations are developed for analyzing the effects of thermal creep on stress distributions. In formulating these elastoplastic equations, the tensile test stress-strain creep data are extended to compound stresses by means of the Mises-Hencky hypothesis. The various equations are manipulated to yield a numerical procedure by means of which the stress and strain components are computed successively at the end of various time intervals. In these calculations it is assumed that the initial creep rates remain constant during each time interval. The resulting equations are applied to the axially symmetric problem of relief of thermal stresses in an infinitely long cylinder which is quickly heated to a parabolic temperature, and maintained at that temperature. End effects are neglected. The calculation is reduced to repeated solutions of a certain second-order ordinary differential equation. Curves are plotted showing the gradual relief of the stresses caused by the creep. The methods developed are illustrative of a procedure which may be followed for other stress-creep problems.

A Theorem of Maximum Strain Energy.....58—A-40

By E. H. Brown, Imperial College of Science and Technology, London, England. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

A new theorem for elastic structures obeying Hooke's law is proved and enunciated as follows: If the strain energy can be expressed in terms of given external loads and the positions of points constrained to have no displacement, then the expression will have a maximum value when the positions are such as make the constraining forces zero. The theorem is generalized to allow a wider class of constraint, such as the attachment of a second, rigid structure to the elastic structure under analysis, in such a way that the two have certain displacement components in common. The principle has been applied by E. H. Mansfield to certain problems in the bending of plates.

Buckling of Struts of Variable Bending Rigidity.....58—A-39

By M. M. Abbassi, Alexandria University, Alexandria, Egypt. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1. 1959).

The differential equation $(d^2y/dx^2) + \phi(x)y = 0$ where $\phi(x)$ is a slowly varying function of x can be solved approximately in terms of trigonometric functions. The solution can be applied to find the critical buckling loads for struts of variable bending rigidity and for uniform struts under the action of varying axial forces. The error in using the approximate formulas for buckling loads is in most cases small, and, for all practical purposes, satisfactory results are obtained.

On Influence Coefficients and Nonlinearity for Thin Shells of Revolution.....58—A-33

By E. Reissner, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

A nonlinear formulation of the problem of rotationally symmetric deformations of thin elastic shells of revolution, which are acted upon by edge forces and moments is reported in this paper. Determined are, in particular, nonlinear corrections to the known results of the linear theory, for edge displacements and rotations. The calculations are for cases for which thickness and curvature of the shell are such as to insure that stresses and deformations are effectively contained within a narrow edge zone of the shell.

A Definition of Stable Inelastic Material.....58—A-31

By D. C. Drucker, Mem. ASME, Brown University, Providence, R. I. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

Definitions given previously for work-hardening and perfect plasticity are broadened to cover viscous effects. As before, the system considered is isothermal and includes both the body and the time-dependent set of forces acting upon it. An external agency is supposed to apply an additional set of forces to the already loaded body. It is now postulated that the work done by the external agency on the additional displacements it produces is positive. Some of the restrictions thus imposed on permissible stress-strain relations are explored. Especial attention is paid to simple laws of creep. Uniqueness of solution also is studied.

The Effect of Turbulence on Slider-Bearing Lubrication.....58—A-30

By Ye Tsang Chou and Edward Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

Based on Prandtl's mixing-length mechanism, the pressure equation for turbulent flow in slider-bearing lubrication is derived. An analytical solution is given and compared with the one for laminar flow. It is found that the turbulent effect increases the pressure and, consequently, the load-carrying capacity. However, the power loss also increases.

ASME TRANSACTIONS

The March, 1959, issues of the Transactions of the ASME—*Journal of Applied Mechanics* and *Journal of Basic Engineering* (available at $1.50 per copy to ASME Members; $3 to nonmembers)—contain the following:

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8 Forced Torsional Vibration of Systems With Distributed Mass and Damping, K. E. Bisshopp. (58—A-8)

13 Frequencies of a Flexible Circular Plate and Light Elastic Half-Space, G. N. Bycroft. (58—A-37)

18 Analytical Design of Disk Cams by Independent Position Equations, F. H. Raven. (58—A-17)

25 Stress Distribution and Plastic Deformation in Rotating Cylinders, E. A. Davis and F. M. Connelly. (58—A-10)

31 Transient and Residual Stresses in Heat-Treated Cylinders, J. H. Weiner and J. V. Huddleston. (58—A-21)

40 The Nonlinear Bending of Thin Rods, T. P. Mitchell. (58—A-50)

44 Stresses and Deflections in Circular Plate Loaded Over a Segment, W. A. Bassali and M. Nassif. (58—A-27)

55 Transverse Flexure of a Thin Plate Containing Two Circular Holes, O. Tamate. (58—A-35)

61 Limit Analysis of Symmetrically Loaded Thin Shells of Revolution, D. C. Drucker and R. T. Shield. (58—A-26)

69 On Influence Coefficients and Nonlinearity for Thin Shells of Revolution, Eric Reissner. (58—A-33)

73 A Theorem of Maximum Strain Energy, E. H. Brown. (58—A-40)

77 Plastic Stress-Strain Relationships—Effect of Loading Path and History, S. S. Gill and J. Parker. (58—A-11)

88 A Stress-Strain Relation for Hexagonal Close-Packed Array of Spheres, J. Duffy. (58—A-53)

95 A Mathematical Model of the Stress-Strain Diagram and Hysteresis Loop, I. R. Whiteman. (58—A-68)

101 A Definition of Stable Inelastic Material, D. C. Drucker. (58—A-31)

107 Retarded Flow of Bingham Materials, Alfred Slibar and P. R. Paslay. (58—A-34)

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1 Ball Motion and Sliding Friction in Ball Bearings, by A. B. Jones. (58—AV-14)

13 A Variational Approach to Lubrication Problems and the Solution of the Finite Journal Bearing, by D. F. Hays. (58—SA-54)

24 On the Necessity of Unsteady Flow in Fluid Machines, by R. C. Dean, Jr.

29 Prediction of Choking Flow in Centrifugal Impellers, by Harold Lown and F. J. Wiesner, Jr. (58—SA-15)

37 Concerning Subharmonic Oscillations Which May Exist in Nonlinear Systems Having Odd Restoring Forces, by C. A. Ludeke and William Pong.

41 An Analytic Frequency-Response Solution for a Higher Order Servomechanism With a Nonlinear Control Element, by A. M. Hopkin and K. Ogata. (58—SA-35)

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49 Analysis and Characteristics of the Three-Lobe Bearing, by O. Pinkus. (58—LUB-2)

56 An Investigation of Dry Adhesive Wear, by R. P. Steijn. (58—LUB-8)

67 Sliding Wear and Metal Transfer Under Unlubricated Conditions, by R. P. Steijn. (58—LUB-9)

79 On the Mechanism of Gear Lubrication, by V. N. Borsoff. (58—LUB-4)

94 The Influence of the Molecular Mean Free Path on the Performance of Hydrodynamic Gas Lubricated Bearings, by Albert Burgdorfer. (58—LUB-7)

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COMMENTS ON PAPERS

Metric System in U. S. A.?

To the Editor:

PURSUANT to the resolution adopted unanimously at the business session of the American Geophysical Union, on May 7, 1958 (AGU Transactions, June, 1958, p. 558), President Maurice Ewing appointed a "Committee on Adoption of the Metric System in the United States."

Bills for the compulsory adoption of the metric system in the United States have been more than once presented to Congress, but they failed, the principal reason being that the effective date proposed was entirely too soon after passage of the bill. An early effective date would undoubtedly work a severe hardship on the adult population not familiar with the metric system, and it would make obsolete a prohibitive amount of everyday items of weights and measures. A solution would appear to be a bill to make the metric system the only official system of weights and measures in the United States, effective in not less than one generation, 33 years, after passage of the bill. Following this action by the Congress, the grade schools and high schools could begin immediately to teach children the metric along with the English system and, during the transition period, could place more and more emphasis on the metric system. By the end of the transition period, the English System could still be taught, but the emphasis would be completely reversed from what it is today.

A long transition would result in a smooth change. In a generation, most items of equipment involving weights and measures normally become obsolete or worn out and replaced. Also, persons engaged in professions and trades now using the English System exclusively would normally pass on to retirement during this period and would be replaced by a new generation thoroughly educated and trained in the metric system.

A questionnaire has been prepared for the purpose of gathering statistical information to indicate the degree of interest in this matter.

Copies of the questionnaire are available upon request addressed to: The Executive Secretary, American Geophysical Union, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. A small effort on the part of interested parties to complete and mail this questionnaire will be of invaluable help to the Committee.

Floyd W. Hough.[1]

[1] Chairman, Committee for the Study of the Metric System in the United States, American Geophysical Union, Washington, D. C.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

A Professional Engineer

How to Become a Professional Engineer

McGraw-Hill Book Company, Inc., New York, N. Y., 1958. Cloth, 5¼ × 8 in., illus., preface, appendixes, index, xiv and 272 pp., $5.50.

Reviewed by W. H. Larkin[1]

THE registration of engineers is fundamentally a device to protect the public from the incompetent and the charlatan. This point is stressed by the author. As he points out, professionalism is a way of life made up of many ingredients, of which registration is one. The book deals primarily with the registration of an engineer and gives a competent review of the many factors involved.

The author himself is registered in New York and New Jersey, is a practicing mechanical engineer, and has been associated with refresher courses in the Metropolitan area for a number of years. He reflects the experience of most Examining Boards when he warns that the "cookbook" approach, namely, the study of sample problems, alone seldom results in a passing grade. He points out that the usual examination is to test the applicant's ability to apply his knowledge of basic engineering science to practical problems.

This work should be a most helpful handbook for the man contemplating registration as a professional engineer.

[1] Eastern Sales Engineer, The Air Preheater Corporation, New York, N. Y. Mem. ASME.

It includes a complete 1956 ECPD listing of accredited engineering curriculums, as well as those courses registered by the New York State Education Department.

Such a listing will assist a candidate to determine his status before a given State Board of Examiners.

Registration on the basis of eminence is still being sought by men with many years of experience. The author summarizes the regulations in the several states for registration of this sort. His detailed analysis of the rules governing Board action in eminence cases reveals the wide range in age and years of experience that constitute minimum requirements in the several states.

This book wraps up between two covers most of the answers to questions which occur to an applicant for registration as a professional engineer. It is well indexed and should be valuable to the EIT candidate, the LS candidate, the PE candidate, and to many who have their licenses and are interested in multiple registration.

Fluid Dynamics and Heat Transfer
By James G. Knudsen and Donald L. Katz. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 576 p., $6^1/_4 \times 9^1/_4$ in., bound. $12.50. Brings together both theoretical aspects and quantitative data on heat transfer and fluid dynamics. The authors discuss the basic differential equations of fluid flow and their application to ideal flow, laminar and turbulent flow past immersed bodies, and flow in heat exchangers. The basic energy equation for fluid flow is derived and applied, along with the momentum equations, to forced convection heat transfer in closed conduits and from immersed bodies.

High Strength Steels for Aircraft
Published 1958 by the American Society for Metals, Cleveland, Ohio. 81 p., $8^1/_2 \times 11$ in., paper. $2.95. Papers discussing chromium ultrahigh-strength steels; steel castings in airframes; use of steel forgings at high-strength levels; materials for hypersonic weapons; machining and fabricating high-strength steels; embrittlement and acceptance testing of high-strength steels. A compilation of papers, presented at the Southwestern Metal Congress, May, 1958.

Induction Motors: Single-Phase and Polyphase
By Charles S. Siskind. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 390 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. Discusses the principles, standards of operation, applications, control, and design of single-phase and polyphase induction motors. Considerable attention is given to the winding and to motor control, and such recent developments as new braking methods and speed-control procedures involving special winding arrangements are presented.

Information and Communication Practice in Industry
Edited by T. E. R. Singer. 1958, Reinhold Publishing Corporation, New York, N. Y. 304 p., $6 \times 9^1/_4$ in., bound. $8.75. Intended as a comprehensive view of the subject, this volume considers technical writing, editing, and illustrating; classification; information services and their part in internal communications; operations research; patent collections; research files; punched cards; training the literature scientist; translating; indexing and abstracting.

Introduction to a Study of Mechanical Vibration
By C. W. Van Santen. Second Revised Edition. 1958, Macmillan Company, New York, N. Y. 310 p., 6×9 in., bound. $8.50. Reviews the elementary theory of mechanical vibrations as well as some of the more important vibration problems encountered in practice. This edition deals in greater detail with vibration amplitude in rotary machines and with the principles of and the instruments for the measurement of vibrations.

BOOKS RECEIVED IN LIBRARY

Kinetic Theory of Gases
By R. D. Present. 1958, McGraw-Hill Book Company, New York, N. Y. 280 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.75. An introduction to the subject covering distribution functions and the perfect gas law; mean-free-path methods and transport phenomena; the Maxwell-Boltzmann distribution law; imperfect gases and intermolecular forces; thermal diffusion; collision dynamics; cross sections, mutual diffusion, and chemical kinetics; brownian motion and density fluctuations.

Linear Programming and Associated Techniques
By Vera Riley and Saul I. Gass. Published 1958 for Operations Research Office, The Johns Hopkins University by The Johns Hopkins University Press, Baltimore, Md. 613 p., 6×9 in., paper. $6. A bibliography containing over 1000 items up to the year 1957. Particular emphasis is placed on applied fields such as production scheduling and inventory control, while certain parallel fields as game theory and linear inequalities are somewhat restricted. Abstracts or annotations are given for most of the items listed.

Machinery and Equipment for Rubber and Plastics
Compiled by Robert G. Seaman. 1958, Rubber World, New York, N. Y. 714 p., $6^1/_4 \times 9^1/_4$ in., bound. $15. The second volume is intended as a supplement to the first, published in 1952. It contains explanations of additional types of equipment such as weighing and measuring, handling and storage, valves and piping, pumps, air-handling equipment, size reduction and separation, fabricating and finishing, decorating and assembly, power transmission, lubrication, and steam generation. Summary articles precede the explanations of each type of equipment.

Mathematics of Physics and Modern Engineering
By I. S. Sokolnikoff and R. M. Redheffer. 1958, McGraw-Hill Book Company, New York, N. Y. 810 p., $6 \times 9^1/_4$ in., bound. $9.50. A text that attempts to strike a balance between the logic of mathematics and its applications. A wide variety of topics are treated such as the use of complex forms of solutions for linear differential equations; mean and pointwise convergence of fourier series; a modern treatment of probability and relative frequency; Dirac's function in connection with the Laplace transform; matrices, vector spaces, and field theory; relation between differential and difference equations.

Nuclear Rocket Propulsion
By R. W. Bussard and R. D. DeLauer. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 370 p., $6^1/_4 \times 9^1/_2$ in., bound. $10. Various aspects of the subject are discussed including heat transfer, structural analysis, fluid flow, thermodynamics, ballistic flight, reactor physics, and radiation safety. Many sections of the volume have applicability to all types of high-power density fission reactor design including mobile and ground power reactors. A feature is the detailed explanation, with examples, of the presently used methods of systems analysis.

Principles and Applications of Random Noise Theory
By Julius S. Bendat. 1958, John Wiley & Sons, Inc., New York 16, N. Y. 431 p., $6 \times 9^1/_4$ in., bound. $11. The author indicates how to formulate difficult noise problems, derive their solutions, and obtain proper physical design and interpretations. The book discusses probability theory, random noise analysis, random processes, engineering systems, correlation functions, power spectral density functions, and optimum filters.

Reactors of the World
Published 1958 by Simmons-Boardman Publishing Corp., New York, N. Y. 12 folded plates, $9 \times 12^1/_2$ in., paper. $2.50. Cutaway drawings with data on operating conditions is provided for twelve nuclear reactors located in Canada, Great Britain, Russia, and the U.S. The drawings were originally published in issues of Nuclear Engineering, London.

Sheet Materials for High Temperature Service
Published 1958 by the American Society for Metals, Cleveland, Ohio. 74 p., $8^1/_2 \times 11$ in., paper. $2.95. Aspects discussed are the properties and applications of precipitation hardening stainless-steel sheet for airframes; high alloys of chromium, cobalt, columbium, molybdenum, and vanadium; ceramic coatings for protection of high-temperature materials; electrical strain measurements at high temperatures; cold roll forming process; joining and inspection of joints. Comprised of papers from the Southwestern Metal Congress, May, 1958.

Successful Process Plant Practices
By Robert L. Davidson. 1958, McGraw-Hill Book Company, New York 36, N. Y. 302 p., $6 \times 9^1/_4$ in., bound. $10. Practical methods and devices to solve different problems relating to managing, scheduling, operating, maintaining, and repairing in the process industries. Pumps, towers, reactors, piping, valves, motors, instruments, exchangers, condensers, machine shops, and insulation are given treatment, and working data are provided such as dimensions, operating conditions, materials of construction, and the tools to be used.

Technology of Columbium (Niobium)
Edited by B. W. Gonser and E. M. Sherwood. 1958, John Wiley & Sons, Inc., New York, N. Y. 120 p., $8^1/_2 \times 11^1/_4$ in., bound. $7. A summary of the present status of knowledge concerning columbium. The seventeen papers included study this metal from the standpoint of economic and supply aspects, properties, extractive and physical metallurgy, analytical problems, and various specialized aspects. The papers were presented at a symposium sponsored by the Electrochemical Society, May, 1958.

Tooling for Metal Powder Parts
By George H. DeGroat. 1958, McGraw-Hill Book Company, New York 36, N. Y. 242 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. Stresses practical aspects of planning and tooling for structural parts such as cams, gears, and latches. Among the factors discussed are designing parts, methods of production and preparation of powders, briquetting techniques, design of briquetting tools, and the various finishing operations. The book was prepared under the direction of the American Society of Tool Engineers.

Trouble-Free Hydraulics
By Ian McNeil. 1958, Ronald Press Company, New York 10, N. Y. 124 p., $5^1/_2 \times 8^3/_4$ in., bound. $6.50. Covers the following areas: an introduction to the hydraulic system and the problems of maintenance; pipework and oil tanks; hydraulic seals and packings; the diagnosis and cure of faults.

ASTM Standards on Gaseous Fuels
Published 1958 by the American Society for Testing Materials, Philadelphia, Pa. 198 p., 6 × 9 in., paper. $3. Standards concerned with the treating, handling, and testing of natural gas, manufactured gas, and liquified petroleum gas. In this edition seven new or revised standards have been included.

Air Intake Problems in Supersonic Propulsion
(AGARDOGRAPH no. 27) Edited by J. Fabri. 1958, Pergamon Press, New York, N. Y. 82 p., 6 × 10 in., bound. $5. Papers on air-intake engine matching problems, presented at the 11th AGARD Combustion and Propulsion Panel Meeting, Paris, 1956. Topics discussed are the various parameters of the supersonic operation of an air intake; a review of supersonic air-intake problems; problems relating to matching turbojet-engine requirements to inlet performances as a function of flight Mach number and angle of attack; factors involved in providing the best experimental conditions.

Aircraft and Missile Propulsion, Vol. 2
By M. J. Zucrow. 1958, John Wiley & Sons, Inc., New York, N. Y. 636 p., 6 × $9^1/_4$ in., bound. $13. This volume, which is the second in a series of three, discusses the methods for analyzing and determining the performance characteristics of the gas-turbine power plant, the turboprop engine, the turbojet engine, the ramjet engine, and the liquid propellant and solid propellant rocket engines. Derivations of the principal equations are explained in detail, and a large number of exercise problems are included along with the answers. A considerable number of references are included at the end of each chapter.

Boiling Water Reactors
By Andrew W. Kramer. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 563 p., $6^1/_2 \times 9^1/_2$ in., bound. $8.50. A brief history is given of the boiling-water-reactor concept and of the early experiments at Argonne, including the development and operation of the Experimental Boiling Water Reactor. The various Borax experiments are then described in detail as is the General Electric Company's Vallecitos plant. In addition a thorough explanation is given of the physics underlying the design of the various reactor plants. The book concludes with a discussion of present and future research and development programs on boiling reactors. A volume in the Atoms for Peace presentation set.

Chambers's Technical Dictionary
Edited by C. F. Tweney and L. E. C. Hughes. Third edition. 1958, Macmillan Company, New York, N. Y. 1028 p., $5^1/_2 \times 8^1/_2$ in., bound. $7.50. A new edition of a standard reference work encompassing the fields of science, engineering, and manufacturing. New terms have been added, while older terms have been revised where necessary to include new aspects.

Coal Mining Law
By John Sinclair. 1958, Sir Isaac Pitman & Sons, Ltd., London, England. 429 p., $5^1/_2 \times 8^3/_4$ in., bound. 50s. Treats legislation relating to coal mining in England and Wales. Emphasis is placed on safety legislation, particularly the Mines and Quarries Act of 1954. Other aspects dealt with are the law of contract, agency, and arbitration, as well as social legislation concerned with the health of workers and their rights in the case of accident or industrial disease.

Coated Abrasives—Modern Tool of Industry
Coated Abrasives Manufacturer's Institute. 1958, McGraw-Hill Book Company, New York, N. Y. 426 p., 6 × $9^1/_4$ in., bound. $8.50. Describes how abrasives are manufactured and the various factors involved in their effective use in the metalworking, woodworking, glass, and plastics industries, and in applications ranging from heavy material removal to fine polishing. Many recent advances are covered including new automatic machinery and various applications such as strip scouring, preplate finishing, and contour finishing.

Davison's Textile Blue Book
Published 1958 by Davison Publishing Company, Ridgewood, N. J. 1225 p., 5 × 8 in. bound. $7.25 (handy edition). A new edition of a standard reference work providing the names and addresses of cotton, woolen, rayon-silk, flax-jute, and knitting mills. In addition, there is information on a wide variety of aspects of the textile industry including factors, converters, and dealers in yarns, silk-rayon, and synthetics.

Economic Operation of Power Systems
By Leon K. Kirchmayer. 1958, John Wiley & Sons, Inc., New York, N. Y. 260 p., 6 × $9^1/_4$ in., bound. $12. A presentation of new analytical and computing techniques that have resulted in significant savings for electric utilities. The author shows how matrix methods are employed to derive transmission-loss formulas, which form the basis for computational procedures utilized in digital computers. The application of analog and digital computers to the problems of calculating transmission-loss formulas and generation schedules is also treated.

Elsevier's Dictionary of Nuclear Science and Technology
Compiled by W. E. Clason. 1958, D. Van Nostrand Company, Inc., Princeton, N. J. 914 p., 6 × 9 in., bound. $25. Contains over 4000 words which are defined in English, with a clear distinction between American and British usage. Each word is defined according to the most precise international standard available. Corresponding terms are then given in French, Spanish, Italian, Dutch, and German arranged horizontally across the facing page. An alphabetical list at the conclusion of the book provides a cross reference from the terms in the non-English languages to the English equivalent.

Engineering Drawing
By Frank Zozzora. Second edition. 1958, McGraw-Hill Book Company, New York, N. Y. 440 p., $8^1/_2 \times 11^1/_4$ in., bound. $6.50. A text covering the fundamentals of engineering drawing, descriptive geometry, and graphical analysis. This revised edition contains new chapters on structural drawing, charts and graphs, electrical drafting, and descriptive geometry, while new material has been added to the sections on freehand drafting, geometrical constructions, dimensioning, and cams and gears.

Entwurf und Berechnung von Stahlbauten, Vol. 1: Grundlagen des Stahlbaues
By Fritz Stüssi. 1958, Springer-Verlag, Berlin, Germany. 577 p., 7 × 10 in., bound. DM 55.50. This first volume of a series on the design and calculation of steel structures covers the following: Steel as a building material; riveted, bolted, and welded connections; numerical solutions in statics; bending and torsion of beams; stability problems—buckling and collapsing; vibration; and the determination of optimum dimensions and characteristics of structural elements.

Fluid Fuel Reactors
Edited by James A. Lane and others. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 979 p., $6^1/_2 \times 9^1/_2$ in., bound. $11.50. Three basic types of fluid-fuel reactors are studied. The first is the aqueous homogeneous reactor. Such factors as nuclear characteristics, properties of aqueous fuel solutions, technology of aqueous suspensions, chemical processing, and design and construction are treated. The second is the molten-salt reactor, with consideration of the chemical aspects, construction materials, nuclear aspects, and heat-transfer systems. The last type presented is the liquid-metal fuel reactor with treatment of such factors as reactor physics, composition and properties of liquid-metal fuels, construction materials, chemical processing, and engineering design. A volume in the Atoms for Peace presentation set. ●

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Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

New Standardized International Inch Incorporated in American Machine Tool Calibrations

THE first American machine tools to incorporate calibrations in the new standardized International Inch, which officially becomes effective July 1, 1959, throughout all English-speaking countries, are the new models of jig grinders, jig borers, and universal measuring machines now being manufactured by the Moore Special Tool Company, Inc., Bridgeport, Conn.

Official announcement of the adoption of the International Inch was made on January 1 by the National Bureau of Standards, giving a six-month grace period for industry to make the necessary adjustments in their measuring systems. After July 1, the Bureau of Standards announced it will calibrate all length measures and gage blocks in terms of the new figure, which is 2 millionths less than the present U. S. inch, and 1.7 millionths greater than the British Imperial inch. The new standard inch coincides precisely with the Canadian inch, which is equivalent to 25.4 mm.

The importance of this difference of 2 millionths of the former U. S. inch is evident in the new Moore Universal Measuring Machine which provides for a tolerance of only 35 millionths of error in a longitudinal travel of 18 in. If the new calibrations were not incorporated, machines could double the tolerance of error owing to the additional error built in by using the old U. S. inch. The Moore Measuring Machine is capable of measuring in terms of one third of a ten thousandths of an inch—a capability designed to provide the required ultra-fine precision needed in the missile age.

The new Model No. 3 Moore Jig Grinder and No. 3 Jig Borer both restrict errors in longitudinal travel to a maximum of 90 millionths in 18 in., likewise, for the utmost in precision measuring and location. The Jig Grinder will perform with split-tenth accuracy, while the Jig Borer will locate, bore, drill, and ream with an accuracy finer than the present limits of the tenth.

The adoption of the new International Inch will serve to eliminate the paradoxical existence of the former small, medium, and long inches, as well as to enforce identical standards in the field of measurement in international intercourse and all scientific co-operation. The countries involved include United States, Canada, Great Britain, New Zealand, Australia, and South Africa.

Enlightened Salary Administration Uses Four-Pronged Guide

A GOOD salary-administration program has a four-pronged objective:

1 It adequately and fairly compensates the personnel within an organization.

2 It encourages individual growth and development.

3 It is competitive in the market place.

4 It provides freedom of action for managers to administer salaries at their level.

"Such a program allows for the 'economic facts of life' and takes into account the financial condition, potential, and profitability of the industry and business," said Richard B. Blomfield, manager, salary administration, Union Carbide Corporation, New York.

Mr. Blomfield addressed the 39th national meeting of the American Institute of Chemical Engineers.

Speaking on enlightened salary administration, he pointed out that salary administration will never be any better or any worse than the basic management philosophy of the company where it is applied.

Salary administration may be administered with a minimum of control or with strict control, the former considered the modern method, he added. Modern enlightened salary administration means that top management establishes and communicates the over-all policies and allocates sufficient funds. It also means that the function of salary administration becomes decentralized and managers are given freedom and authority to act.

"Guidance in salary administration implies delegation," Mr. Blomfield said. "It means that salary administration becomes a line function and the managers utilize it as an important factor in running their departments. They apply salary increases as a constructive instrument in employee relations."

"By fixing as much of the responsibility as possible at the point of contact between the employee and his supervisor, modern salary administration tends to eliminate 'passing the buck'. It makes many contributions to a company but in the long run its most important contribution is the creation of employee morale."

He gave this definition of morale by Dale Purves of Edward N. Hay Associates: "Morale is the product of a belief of man in himself, in what he is doing, and in the people he is doing it with. It is a belief, not just in his immediate associates, but in the entire organization. It's a belief in many top management fellows whom he has never met."

"We cannot create this kind of morale by slapdash or casual application of borrowed techniques in salary administration," Mr. Blomfield said. "We have to cut the cloth to fit the job. Thank goodness this is being done more frequently in more companies every day."

Julio Kilenyi, Designer of ASME 50th Anniversary Medal, Dies

JULIO KILENYI, sculptor and designer of medals, medallions, and plaques, died January, 1959, in New York City.

He was known particularly for the commemorative medals he did for the Port of New York Authority—such as that of the Bayonne (N. J.) Bridge in 1931—and for societies and groups. Typical of the latter was one marking the fiftieth anniversary of The American Society of Merchanical Engineers (1930) and the plaque (1931) that commemorated the round-the-world flight of Wiley Post and Harold Gatty.

Mr. Kilenyi was born in Arad, Hungary, studied in Budapest and in France and Germany, and did some of his early sculpture work in Argentina (1907–1916). He came to the United States in 1916 and was naturalized in 1924.

His work is represented by medallions and plaques on permanent exhibit at the Metropolitan Museum of Art, the Cleveland Museum of Arts, the Boston Fine Arts Museum, the Smithsonian Institution, the British and Victoria and Albert Museums in London, the New York Historical Museum, Oxford University, the Franklin D. Roosevelt Library, the Vatican Museum in Rome, and others.

International Industrial Exhibition to Open in São Paulo in 1960

SEVENTEEN Brazilian affiliates of major American companies plan to participate in an international industrial exhibition, to be held in São Paulo, Brazil, for 18 months beginning April, 1960.

To be known as the Industrial Latin America Partnership Exhibition (ILAPE), the event was announced recently by Thorsen Enterprises of New York. ILAPE is being sponsored by the Federation of industries of São Paulo and the city of São Paulo, and administered by the Sociedade de Cooperacao Internacional, a nonprofit membership corporation expressly organized for the exhibition.

Termed a "growing concept in partnership," the exhibition is designed to show the world:

1 The remarkable partnership, already existing in Brazil, between foreign capital, technical know-how, and management; and Brazilian capital, labor, and resources.

2 The profit potential of partnership with Brazilians for foreign companies seeking to expand in the Brazilian market.

3 A working demonstration of how countries similar to Brazil can upgrade their economies, making it conducive for foreign capital to seek similar "partnership relationships."

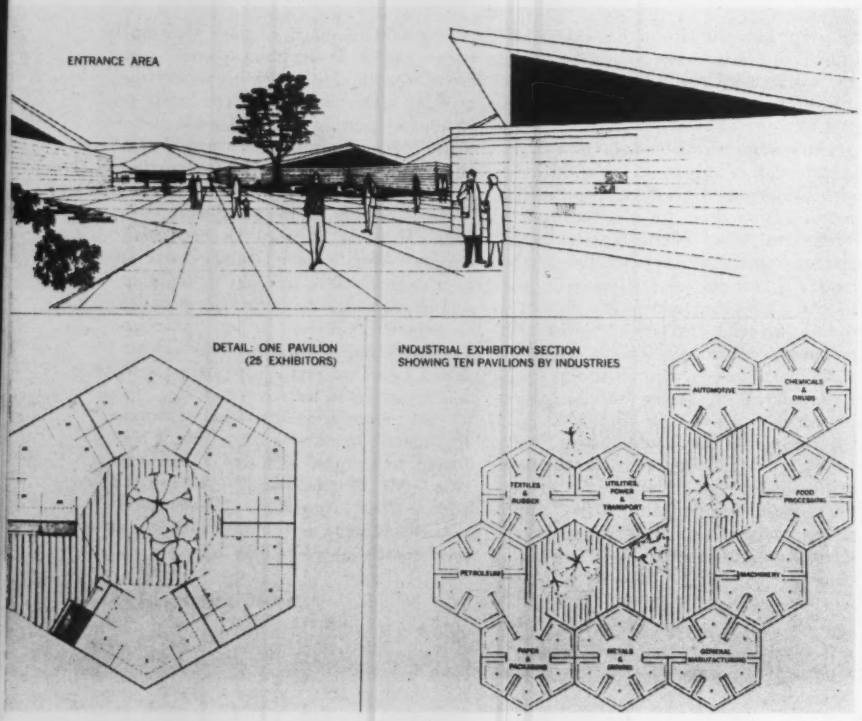
This approach, it was pointed out, can result in an increase in earnings, jobs, expansion of the gross national product for Brazil. And for the American corporation in Brazil, on a partnership basis, it means an increase in sales, profits, net worth, easier access to raw materials, and diversification on a global scale. As Europe heads toward a common market, Latin America also is learning the language of regionalism.

The International Latin America Partnership Exhibition will be held in the heart of São Paulo, in the magnificent Parque Ibirapuera. Approximately 250 exhibitors in 10 hexagonal pavilions will show by means of three-dimensional scale models and other visuals how their companies' products are made and how manufacture and distribution of these products helps improve the Brazilian economy.

By participating in ILAPE, according to Thorsen, the American exhibitor will automatically provide his company with the most thorough-going exposure to the Brazilian economy, including government, industry, suppliers, distribution outlets, capital, and consumer.

The following Brazilian affiliates of American companies are planning to take part in ILAPE: Union Carbide Corporation; E. I. duPont de Nemours and Company; The Bordon Company; Ford Motor Company; Willys-Overland Motors Inc.; International Basic Economy Corporation; Anderson Clayton & Company; Swift & Company; Sterling Drug Inc.; American Can Company; Standard Oil Company of New Jersey; General Motors Corporation; American Machine & Foundry Company; Johnson & Johnson; Olin-Mathieson Chemical Corporation.

More than 500,000 visitors are expected to attend the exhibition. The New York offices of Thorsen Enterprises will serve as an information center for ILAPE. Previews International Limited will serve as fiscal agent in the United States.



The Industrial Latin America Partnership Exhibition (ILAPE) will open in the magnificent Parque Ibirapuera, in the heart of São Paulo, Brazil, for 18 months beginning in April, 1960. There will be a total of 250 exhibition units in 10 pavilions, each pavilion housing the industries shown in the diagram, *lower right*. At the *lower left* is a close-up of a single pavilion, detailing the units by number.

Report on Engineering Enrollments and Degrees

For the first time in seven years, and despite still-critical demands for engineering talent, enrollment in American engineering schools is on the decline.

The 153 accredited American engineering colleges had 2.9 per cent less students in the fall of 1958 than in the fall of 1957. And the freshman class which entered last fall was 11.6 per cent smaller —59,164 instead of 67,071—than 1957.

Declining enrollments have not yet affected the number of engineering graduates—31,216 in 1957-1958 compared with 27,748 the previous year. But the numbers are far short of the record graduation of eight years ago, when World War II veterans were finishing their delayed college careers.

These engineering enrollment figures come from the annual official survey of students and degrees conducted by the American Society for Engineering Education in co-operation with the U. S. Office of Education. Final results were reported by Justin C. Lewis, Head of Higher Education Statistics, and Dr. Henry H. Armsby, Chief for Engineering Education, both of the U. S. Office of Education.

Fears of dropping engineering enrollments were confirmed by the official figures. Engineering students are now less than 7.7 per cent of all American college students, compared with nearly 8.5 per cent in 1957. Enrollment of second-year students is down 6 per cent from last year, and third-year students are down 4 per cent. Only in the fourth and fifth-year category does this year's enrollment total as large as last year's. This gives promise of more graduates in June, 1959; but there may be fewer in the years thereafter.

Graduate study in engineering continues to increase sharply, and enrollment is now at record levels, according to the ASEE-Office of Education figures. This fall 27,456 students were enrolled in master's degree programs, an increase of 14.7 per cent over 1957; and 4762—up 14.3 per cent—were studying for doctor's degrees.

Last year 5751 master's degrees were given in engineering, nearly 10 per cent of all master's degrees given in the United States during the year. There were 653 doctor's degrees, 8 per cent of doctor's degrees given in all fields.

Electrical engineering with slightly over 56,000 undergraduate students is by far the most popular engineering field; just over 8700 bachelor's degrees in electrical engineering were awarded in 1957-1958. Next comes mechanical engineering, with nearly 44,000 students and 7850 graduates. Civil engineering, third in popularity, accounted for just under 15 per cent of the bachelor's degrees, a proportion somewhat lower than in recent years.

Electrical engineering is also most popular among graduate students, with chemical engineering second, and mechanical engineering third.

In all, 1396 women were studying for bachelor's degrees in accredited engineering schools in the fall of 1958, less than 1 per cent of the total enrollment.

All figures released cover only the 153 American colleges with one or more of their engineering curriculums accredited by Engineers' Council for Professional Development. In 70 other schools, on which the U. S. Office of Education reports independently of ASEE, there were 39,047 undergraduate engineering students enrolled this fall, and 4116 degrees were awarded in engineering in 1957-1958.

The ASEE report giving statistics by class level in each institution was in the February 15, 1959, Yearbook issue of the *Journal of Engineering Education*. The U. S. Office of Education report giving data in each curriculum will be in its Circular No. 555. Both publications will be available March 1.

Cooper Union to Get New Engineering Building

Expansion is the keyword in academic circles throughout the nation. Schools everywhere are sponsoring vast building programs to meet the needs of the rapidly growing student population.

Cooper Union, a tuition-free school and a landmark on the educational scene since shortly after it opened in 1860, is going along with the trend.

Construction of a new building planned for the Cooper Union School of Engineering will be started late this spring. Announcement was made by Dr. Edwin S. Burdell, president of The Cooper Union for the Advancement of Science and Art.

According to a schedule prepared by Vermilya-Brown Company, Inc., re-

Rendering of new building planned for Cooper Union School of Engineering. Building, designed by Voorhees Walker Smith, Smith & Haines, should be ready for occupancy in fall of 1961. The $4-million structure which unites for the first time all of the departments of the engineering school, will be erected on the former site of New York's Bible House, in the city block bounded by Third and Fourth Avenues, Ninth Street, and Astor Place. It will stand immediately north of the Cooper Union's original Foundation Building, which was built more than 100 years ago by Peter Cooper, New York industrialist and philanthropist.

cently appointed as general contractor, construction is expected to proceed fast enough to allow for a cornerstone-laying ceremony on Sept. 23, 1959, which will be the 106th anniversary of the laying of the cornerstone of the Foundation Building.

The present plan provides for 100,000 sq ft of floor area, arranged in three wings of six stories, five stories, and one story above ground, respectively. There will be a full basement floor under the entire structure. The area at the corner of Third Avenue and Astor Place will provide a terraced patio enclosed by an open arcade. The building will be of steel and concrete construction faced with brick and stone, with aluminum windows, spandrels, and arcades.

Interior arrangement provides for the grouping of related laboratories, classrooms, and offices of each engineering specialty on the same floor. Provision is made for 22 large, well-lighted classrooms, as well as a modern auditorium for public speaking and dramatic work.

Cullimore Hall Dedicated at Newark College of Engineering

Allan R. Cullimore served as president of Newark College of Engineering from 1920 to 1949. He died in 1956. Dr. Cullimore had been an illustrious member of ASME, and had long been a member of the Society's Committee on Engineers Civic Responsibility.

Newark College of Engineering has recently dedicated a new building, Cullimore Hall, to the memory of its late president.

Cullimore Hall is one of two new buildings to be financed from a total of $2\frac{1}{2}$ million in state appropriation and $500,000 in city aid. The six-story building which houses classrooms, offices, a cafeteria, and student center has been in use since last May.

Gov. Robert B. Meyner, who was among the officials attending the ceremony, praised Dr. Cullimore for "giving to engineering education, during a long lifetime, a scope and direction which has influenced every other college in the land."

His influence established the study of the humanities on an equal level with technical studies. He based the ruling philosophy of the College on two principles: that engineering is a discipline, requiring the highest ideals of work and ethics; and that the engineer, by virtue of his specialized training in logical and creative thinking, has a special duty as a citizen.

It was Allan R. Cullimore's contention that "To be a successful engineer, a man must first be a successful human being..." Dr. Cullimore was such a man; and, in the hall which bears his name, his ambitions for engineering education will continue to be realized.

Mrs. Allan R. Cullimore, widow of the late president of Newark College of Engineering, unveils plaque in his memory at dedication of new Cullimore Hall at the college. Looking on, *left to right*, Gov. Meyner, Robert Van Houten, college president, and John W. Seaholtz, student president.

Planning and Controlling Capital Expenditures

The Engineering Economy Division of ASEE and the Engineering Economy Research Committee of AIIE are cosponsoring a two-day conference featuring industrial applications of engineering economy and related management techniques. The theme of this symposium is "Applications of Economic Evaluation in Industry." Topics covered include capital budgeting and project justification, project post audit analysis, estimation of working capital requirements, effects of taxes on project justification, and the evaluation of uncertainty. Speakers include leaders in these fields from both industry and academic institutions.

This conference will be held at Carnegie Institute of Technology and the University of Pittsburgh, Saturday and Sunday, June 13 and 14. The registration fee is $25 with a special rate of $5 for academic personnel. Registrations and requests for further program details should be sent to Markwick K. Smith, American Telephone and Telegraph Co., Room 1104, 195 Broadway, New York 7, New York.

COMING MEETINGS

Biomechanics Symposium

The Institution of Mechanical Engineers on April 17, 1959, will sponsor a symposium on biomechanics to discuss developments in the application of mechanical engineering to the field of medicine and surgery. Biomechanics deals with the application of engineering principles and the employment of engineering techniques in a study of living things, whether in health or disease.

Four papers will cover the subjects of metallic osteosynthesis, lubrication of animal joints in relation to their replacement by mechanical devices, materials for artificial mechanical joints, and workable substitutes for missing or defective limbs.

CIMAC

THE 1959 International Congress on Combustion Engines will be held in Wiesbaden, Germany, June 14–19. Theme of the Congress will be diesel engines and gas turbines up to 1500 hp. Approximately 30 papers will be delivered during the first four days of the Congress, the remaining time to be devoted to inspection trips. A concurrent program also is planned for the women.

The Oil and Gas Power and the Gas Turbine Power Divisions of ASME are among the sponsors of the Congress. For further information, address R. L. Stanley, Secretary-Treasurer, Room 403, 2000 K Street, N. W., Washington 6, D. C.

Hydraulic Research

THE Eighth Congress of the International Association for Hydraulic Research will he held August 24–29 in Montreal, Canada. Technical sessions will be held at the Ecole Polytechnique on the university campus. One of the features of the congress will be a tour of the St. Lawrence Seaway and the Beauharnois Hydroelectric development. For further information, write to Mr. Leo Roy, % Quebec Hydro-Electric Commission, 107 Craig Street West, Montreal 1, P. Q., Canada.

Instrumentation

THE Gordon Research Conferences for 1959 will be held during the months of June to September in New Hampshire. A conference on instrumentation will meet at Colby Junior College, New London, N. H., on August 24–28. Papers invited include such subjects as instrumentation for satellite and rocket experiments, for industrial psychology, and instrumentation in automotive research. Other papers treat new methods, principles, and techniques in the field of instrumentation.

Requests, for additional information, should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, R. I.

Fracture

THE National Academy of Sciences-National Research Council has announced that a seminar on the atomic mechanisms of fracture will be held in Cambridge, Mass., April 12–14, 1959. Open to interested technical persons, this conference will feature invited papers from the U. S. and abroad on the following topics: theoretical aspects of fracture, cleavage, crystalline and noncrystalline fracture, fatigue and ductile fracture, high-temperature fracture. Further information will be available from Dr. B. L. Averbach, Chairman, or Dr. D. K. Felbeck, Secretary, Conference on Fracture, National Academy of Sciences-National Research Council, Washington, D. C.

Industrial Research

THE Department of Industrial Engineering of Columbia University, New York City, has announced that the annual industrial research conference will be held at Arden House, Columbia's Harriman Campus from May 31 through June 5, 1959.

Representatives from industry, government, and universities will participate in lectures, panel discussions, and group meetings of the registrants—research and development administrators who represent a cross section of U. S. industry from small laboratories to the largest in the country. Inquiries may be addressed to Prof. R. T. Livingston, Director, Industrial Research Conference, 409 Engineering, Columbia University, New York 27, N. Y.

High-Speed Literature Searching Selector Makes World Scientific Document Center Possible

POSSIBILITY of the establishment of a scientific world document center moved nearer with the announcement by Western Reserve University President John S. Millis, that the General Electric Company would build a high-speed prototype of the WRU searching selector called the GE-250.

The selector will enable the WRU document specialists to search scientific and other documents much more rapidly and efficiently and will furnish the proposed world document center with one of its most important tools.

A GE spokesman said the GE-250 is designed to allow automatic reviewing and comparing, at very high speed, of extensive files of information to determine which piece of information answers in whole or part a specific inquiry.

Compared with the old WRU selector which could search 30 abstracts per hour, the new one when completed will search 100,000 abstracts per hour.

For example, the new machine will be able to search the year's output of the world's metallurgical literature in six minutes, the year's output in chemical literature in one hour, or an entire collection of company reports in several minutes. The machine would complement the work of large computers in providing processed data for management decisions.

A three-year experimental project conducted by WRU's Center for Documentation and Communication Research for the American Society for Metals has proved the feasibility of searching metallurgical literature by machine.

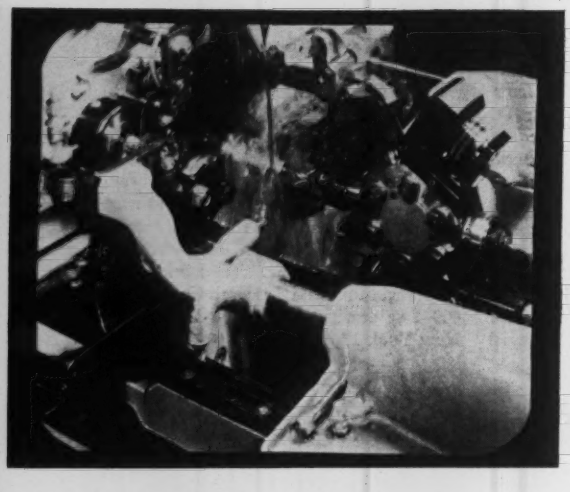
The first large scale push in the U. S. for an effective world document center was started at Western Reserve University in February, 1958, when representatives of 150 professional and technical societies (including ASME), government agencies, foundations, and industry met to consider WRU's plan for the co-ordination of the world's scientific and technical information.

Major steps since that time include: Hearings in May, 1958, before Senator H. H. Humphrey's Subcommittee on Reorganization (committee on government operations); presentation of the WRU plan to the National Research Council for study in mid-1958; Allen Kent's (associate director of WRU center) trip to Moscow to study Russian developments in scientific documentation in September, 1958; and President John S. Millis's recent appointment to the advisory committee of the Science Information Service of the National Science Foundation.

AEC Films

THE Atomic Energy Commission has announced the availability of 45 technical films first screened in Geneva at the Second International Conference on Peaceful Uses of Atomic Energy. A list which describes the 16-mm films, gives sales prices, tells where they may be borrowed or purchased, and specifies the limitations that apply to certain films. Subjects covered include research and test reactors, reactor safety, fuels and processing, particle accelerators, and the like.

Inquiries may be directed to the Public Information Service, U. S. Atomic Energy Commission, Washington 25, D. C.



Automatic Screw Machines

"Engineered Screw Machine Tooling Application" is a 16-mm, color, sound film produced by the Brown & Sharpe Manufacturing Company. Eight practical applications of the latest design automatic screw machines are featured. Standard and special attachments with explanations of the tool engineering involved in their practical application are described. The 35-min film is available on a loan basis from Brown & Sharpe Manufacturing Company, Machine Tool Division, Providence, R. I. Typical parts produced in the filming are shown here.

Welding Electrodes

"From Sea Sands to Better Welding" features the many fascinating steps involved in mining rare and valuable minerals for electrode coatings. The 16-mm, color, sound film pictures millions of tons of mineral-bearing sand being moved and processed to secure important basic materials for better welding electrodes. The film runs 18 min, and may be borrowed from Hobart Brothers Company, Troy, Ohio.

RESEARCH

Martin-Baltimore Reorganizes

In an effort to reallocate engineering talent and resources in such a manner as to take greatest possible advantage of human know-how and talents, the Martin-Baltimore Division of the Martin Company, Baltimore, Md., has launched a new concept of engineering for the Space Age.

Breaking sharply with traditions of the aviation industry, Martin-Baltimore reorganized its 2000-man engineering staff into separate "task forces" to develop and deliver unsurpassed manned vehicles, missiles, and electronic systems.

Replacing the previous single engineering division are two new organizations—Manned Vehicles and Missiles-Electronics.

Several new categories of research and development activity, particularly in the field of electronics, will be raised to project status. For the Missiles-Electronics Division such new projects as ground-support equipment, antisubmarine warfare, reconnaissance, and guidance and navigation are listed. Each of the projects will have equal administrative status with a project organization such as the USAF Mace tactical missile.

Rocket-Component Materials

Calumet & Hecla, Inc., Allen Park, Mich., has announced a threefold expansion of research facilities which will enable its Wolverine Tube Division to intensify its efforts in the development of materials used in missile, rocket, and atomic energy fields. All three fields require materials having special properties such as high heat strength or low neutron absorption.

Materials being studied include molybdenum, zirconium, niobium, vanadium, tantalum, titanium, and tungsten. Fabrication techniques under study include hot and cold extrusion, high-velocity forming, and spin forming. Supplementing theoretical studies in the heat transfer phenomena of extended surface tubing that are sponsored by Wolverine Tube at the University of Michigan at Ann Arbor, work is under way on the development of new types of extended surface tubing. Extended surface or "finned" tubing permits the design of more efficient and more compact heat exchange equipment for use in atomic energy, solar heating, and thermoelectric devices.

Research Economics

A new mathematical formula to tell industry how much money can profitably be spent on research is part of a long term study now under way at Case Institute of Technology.

Described in the new Case publication *Case Work*, the study is supported by the National Science Foundation. During 1959, the Operations Research group hopes to complete a manual which can be used by individual firms as a guide to how much money should be spent on research and development to produce the greatest profits.

Another part of the study will be the establishment of standards for individual research projects, so that management may be able to pick the best projects and when they should begin and end.

In a second stage of the study, an attempt will be made to extend the findings for individual firms to an entire industry, such as the chemical industry.

In the third and final stage, the formula will be extended to the entire economy of the nation.

MEETINGS OF OTHER SOCIETIES

April 13–17

American Foundrymen's Society, castings congress and engineered castings show, Sherman and Morrison Hotels, Chicago, Ill.

April 14–17

The Iron and Steel Institute, London, Iron and Steel Engineers' Group meeting and inspection trip, Grand Hotel Krasnapolsky, Amsterdam, the Netherlands

April 20–22

Mathematics Research Center, U. S. Army, symposium on boundary problems in differential equations, University of Wisconsin, Madison, Wis.

April 21–23

American Society of Lubrication Engineers, annual meeting and lubrication exhibit, Hotel Statler Hilton, Buffalo, N. Y.

May 5–7

Purdue Industrial Waste Conference, Purdue Memorial Union Building, Lafayette, Ind.

May 7

Society of Plastics Engineers, Inc., Pittsburgh Section, plastics in the metal industry, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 11–13

Instrument Society of America, Kansas City Section, second annual power conference, Hotel President, Kansas City, Mo.

May 14–15

Operations Research Society of America, annual meeting, The Shoreham Hotel, Washington, D. C.

(For ASME Coming Events, see page 139)

UNITED ENGINEERING CENTER

A Message to All Members of the Engineering Societies Co-operating in the United Engineering Center

Mervin J. Kelly, General Chairman, Industrial Building Fund Committee, United Engineering Center

Our New Center. We are in the midst of the campaign for funds for the construction of the new Engineering Center—the headquarters of ten Societies. If the Societies are to meet their obligations of today and the challenges of tomorrow, the new Center must be provided.

The threat that now faces our society and, in fact, all free peoples is the tragedy of our times. Russia's oftenstated purpose of communizing the world with the utilization of her rapidly increasing military and economic strengths to attain this goal is the threat we face. It can only be countered by equal or greater strengths in our nation and the associated free societies. These strengths are determined by the scientific and technologic development of our nation and associates.

To counter this threat, our nation's scientific and technologic capacities must be developed to the highest possible level, only limited by the inherent capacities of our people. The Societies make large contributions to the nation's technologic strength through the many services they render to engineers. They provide a professional framework for engineers. They provide publications, meetings, and forums for presenting information on technologic progress. They aid in the development of young engineers through establishing standards for engineering education, through student-branch activities and through the impact of their publications on engineering curriculums.

The present Center—now more than 50 years old—is wholly inadequate; it is limiting the effectiveness of the Societies. The new Center is essential. Its location across from the United Nations is an ideal setting, typifying the Societies' national and international importance. The building, while strictly functional, has an impressive dignity and a necessary large size that give striking evidence of the magnitude of the Societies' activities.

Progress of the Funds Campaign. In late 1957, based on an estimated cost of $10 million for building and land, a quota of $5 million was established for the nation's industries and $3 million for members of the Societies. The value of present building and site was appraised at $2 million. Industry's campaign began under my leadership in November, 1957. The membership campaign began some six months later. At mid-February some $4 million had been subscribed by industry and $2 million by members of the Societies. Splendid progress has been made.

We must not only meet our goals of $5 and $3 million, respectively, we must exceed them. Building costs have advanced since the 1957 estimate and the site cost was greater than anticipated. There is adequate potential both from industry and from the Societies' membership for our going well beyond the goals—adequate to cover cost of building and site.

The industry solicitors are proceeding with renewed zeal in their solicitation of all industry that employs engineers who are members of the Societies. As a cleanup, beginning in June of this year, I shall personally resolicit the chief executive of each company that has not subscribed whose company has a gift potential of $5000 or more.

In the membership campaign, 40,000 members have subscribed $2 million. Certainly, it is not too much to anticipate another $2 million from the remaining 140,000 members.

I consider it an opportunity, a duty, and a solemn obligation for each member of the Societies to participate in funding the new Center. Let us strive for a 100 per cent participation!

Turner Construction Named UEC General Contractor

The Turner Construction Company of New York was named as the general contractor for the United Engineering Center. This new headquarters of the nation's leading engineering societies will be erected on the west side of United Nations Plaza between 47th and 48th Streets in New York, N. Y.

The announcement was made by Andrew Fletcher, president of United Engineering Trustees, Inc., and president of St. Joseph Lead Company of New York.

Space has been set aside in the building for educational exhibits which will dramatize the creative role of engineers in advancing world living standards. The metal, glass, and limestone structure, fully air-conditioned, will occupy a site of 37,000 sq ft.

United Engineering Center Building Fund (as reported on March 20, 1959)

Member Gifts Campaign Status

	Quota	Subscriptions	Number of subscribers	Per cent of quota
ASCE	$800,000	$ 431,930.14	6,560	51.5
AIME	500,000	240,303.38	3,040	48.0
ASME	800,000	459,139.54	9,198	57.3
AIEE	900,000	715,068.90	18,792	79.6
AIChE	300,000	282,443.05	6,668	93.8
Other	....	38,835.41	439	....
Total Member Gifts		$2,167,720.42	44,697	72.4

Industry Gifts Campaign Status

Total Industry Gifts	$4,122,933.00	381	82.4

THE ASME NEWS

St. Louis, "Gateway to the West," Site of 1959 ASME Semi-Annual Meeting

Top-notch technical program plus attractions of historic, "air-conditioned" St. Louis will do much to draw a large audience

THE St. Louis Section of The American Society of Mechanical Engineers, in the role of host to the 1959 Semi-Annual Meeting, June 14 through 18, at the Chase-Park Plaza Hotel, has several plans under way.

Acting through its 16-man General Arrangements Committee, the St. Louis Section, with the assistance of the Meetings Committee and various programming agencies of the Society, is developing a program which should make this one of the most interesting and instructive meetings to be held by ASME in recent years.

Technical Program

The technical program is still in the formative stage. Authors and proper paper titles have not been announced, but there are definite plans for 33 technical sessions. There will be one or more sessions on Air Pollution, Aviation, Fuels, Heat Transfer, Human Factors in Engineering, Education, Junior Engineers, Lubrication, Machine Design, Maintenance, Management, Materials Handling, Professional Practices, Nuclear Engineering, Oil and Gas Power, Power, Process Industries, Rubber and Plastics, and a general session on Water Resources sponsored by the Technical Development Committee.

The luncheon meetings schedule is fast reaching the final stage for the Management Division, the Power Division, and the Technical Development Committee. The President's Luncheon on the first day will open the social program. The one evening meeting listed is the Banquet, Wednesday, June 17. Principal speaker at the Banquet will be General Lief J. Sverdrup who also will present the "Spirit of St. Louis" awards for recognition of outstanding contributions in the field of aviation.

The women's program will be of general appeal and interest. The committee is presently in the process of pouring over plans and alternate plans to insure a superlative week for the visitors.

The Early-Bird Party on Sunday, June 14, will be the starting point for fellowship and entertainment. The evenings, being open on the program, have a selective list of open-air opera, baseballl, river excursions, night clubs, restaurants, theatres, and restaurants to suit a variety of tastes.

Historic St. Louis

St. Louis, located at the confluence of the Mississippi and Missouri Rivers, has great historical significance, and visitors will find great interest in visiting the Old Court House, the Old Cathedral, authentically maintained residences such as the Campbell House and the home of Eugene Field, and even such antiquated machinery as the vertical, triple-expansion steam-driven pumps installed prior to

General Arrangements Committee of ASME St. Louis Section gather to complete plans for 1959 ASME Semi-Annual Meeting, June 14–18, at Chase-Park Plaza Hotel. Seated, *left to right,* R. O. Slattery, J. A. Albert, R. M. Boyles, and Bruce Conlin of Headquarters. Standing, C. B. Briscoe, J. R. Buss, H. E. Frech, W. H. Weber, and G. H. Sample. Missing due to a severe blizzard are G. P. Dorris, J. K. Bryan, Dave Larkin, L. W. Morrell, G. C. Maechler, W. J. Oonk, C. K. Kippenhan, and Mrs. Irma Oonk. Photo was taken by Val Beach, Committee photographer.

1900 and still in use at one of the waterworks pumping plants. The log-cabin residence of President Grant, located on the Busch estate, also may be seen.

Civic Pride

Points of special civic interest in the entertainment field center around the world famous open-air Municipal Opera in Forest Park and the outstanding Zoo. The Missouri Botanical Garden, popularly known as Shaw's Garden, and the Jewel Box provide superb botanical displays. The Steamer Admiral, operating on the Mississippi River, and the old-fashioned Goldenrod Showboat, with its melodrama of years ago, attract many visitors. The new air terminal has been a matter of international interest.

On the cultural side there are the St. Louis University and Washington University, the Art Museum, and New Cathedral with its very fine Mosaics.

Industrial St. Louis

Industrially, St. Louis has achieved a diversity which is unique. Worthy of special mention is the world famous Anheuser Busch Brewery; the Emerson Electric Plant; Granite City Steel Company's rolling mill blast furnaces and open hearths; McDonnell Aircraft Corporation, with its extensive jet and rocket facilities; Mallinkrodt Chemical Company, with its Weldon Spring Atomic Works for purification of uranium ores; the automobile assembly plants of Mercury, Chevrolet, and Plymouth, which make St. Louis the largest assembly point in the country; the Olin-Mathieson plant at nearby Alton; the Monsanto Chemical Company plants; the Public Service Company bus-maintenance facility which has won the national award for each of the past 13 years; the large Shell and Standard refineries at adjacent Woodriver; the Union Electric Company's new Meramec Plant, which has excited national interest; and the Wagner Electric plants. These are just a few of the interesting industrial operations which are located in St. Louis. Several of these plants will be inspected by groups in attendance at the Semi-Annual Meeting.

The St. Louis Section is making plans—are you?

ASME Maintenance and Plant Engineering Conference Features Forum

THE second annual Maintenance and Plant Engineering Conference of The American Society of Mechanical Engineers will be held on May 4 and 5 at the Edgewater Beach Hotel, Chicago, Ill.

The ASME Chicago Section cosponsors the meeting. The American Institute of Plant Engineers has been invited to participate.

Outstanding features of the meeting include a Maintenance Forum, a talk by ASME President G. B. Warren on the importance of high-level maintenance and plant engineering, and a tour of the Chicago North Side Filtration Facility.

▶SUNDAY, MAY 3

Early Registration

▶MONDAY, MAY 4

Registration **8:30 a.m.**

Session 1 **9:30 a.m.**

Chairman: *B. G. Evans*, Eli Lilly and Co., Indianapolis, Ind.

Technique of Efficient Sandblasting, by *P. E. Weaver*, Dow Chemical Co., Baton Rouge, La. (Paper No. 59—MPE-1)

Practical Aspects of Protective Coating Specifications, by *Guerard Mackey* and *J. R. Allen*, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Maintenance of Parking Lots and Grounds, by *A. K. Carter*, Eli Lilly and Co., Indianapolis, Ind.

Luncheon **12:30 p.m.**

Presider: *S. A. Simonson*, president, American Inst. of Plant Engineers

Session 2 **2:30 p.m.**

Chairman: *A. J. Schertfeger*, E. I. du Pont de Nemours & Co., Inc., Aiken, S. C.

Engineering for Good Refinery Maintenance, by *E. R. Schauffe* and *H. W. Parsons, Jr.*, Atlantic Refining Co., Philadelphia, Pa.

Role of Central Shops in Area Maintenance, by *C. H. Harker*, Caterpillar Tractor Co., Peoria, Ill.

Banquet **7:00 p.m.**

Presider: *M. V. Maxwell*, chairman, ASME Chicago Section

Speaker: *Glenn B. Warren*, President, ASME

Subject: **The Importance of High-Level Maintenance and Plant Engineering**

▶TUESDAY, MAY 5

Registration **8:30 a.m.**

Session 3, Maintenance Forum **9:30 a.m.**

Chairman and Moderator: *K. P. Powers*, Gulf Research and Development Co., Pittsburgh, Pa. Vice-Chairman: *G. G. Halfinger*, Midwest service manager, Combustion Engineering, Inc., Chicago, Ill.

Forum Members

J. D. Quinn, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

J. H. Duncan, president, Work Factor Co., Haddon Heights, N. J.

J. V. Sheridan, senior staff engineer, Commonwealth Edison Co., Chicago, Ill.

J. E. Lockhart, manager, plant engineer, General Electric Co., Cincinnati, Ohio

Tour of the Chicago North Side Filtration Facility **2:00 p.m.**

ASME Papers By Mail

ONLY *numbered* ASME papers in this program are available in separate copy form until Feb. 1, 1960. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 40 cents each to members of ASME; 80 cents to nonmembers. Papers must be ordered by the paper number listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

ASME Pittsburgh Section Program in the Pittsburgh Bicentennial Conference

THE Pittsburgh Section of The American Society of Mechanical Engineers is sponsoring a two-day meeting on the theme, "Air-Pollution Problems and Their Solution—The Contribution to Pittsburgh's Renaissance." The conference will be held April 20-21, at the Penn-Sheraton Hotel, Pittsburgh, Pa.

▶MONDAY, APRIL 20

Registration **8:30 a.m.**

Technical Session **10:00 a.m.**

Chairman: *T. E. Purcell*, Fellow ASME, consulting engineer, Pittsburgh

Vice-Chairman: *E. S. Howarth*, Mem. ASME, chief, mechanical-engineering div., ALCOA Research Labs, New Kensington, Pa.

Background of Air-Pollution in Pittsburgh—the Forces Which Motivated the Program, by *John Grove*, Allegheny Conference on Community Development

The Pittsburgh Plan and Its Implementation, by *T. C. Wurts*, Bureau of Smoke Control, Allegheny County

Luncheon **12:30 p.m.**

Presiding: *N. H. Eckler*, Vice-Chairman, ASME Pittsburgh Section, design engineer, Gulf Research and Development Co., Pittsburgh

Introduction by *E. R. Weidlein*, president-emeritus, Mellon Inst.

Speaker: To be announced

Technical Session **2:30 p.m.**

Chairman: *Tomlinson Fort*, Mem. ASME, vice-president, Westinghouse Elec. Corp.

Vice-Chairman: *D. W. VerPlanck*, Mem.

ASME, head, Department of Mechanical Engineering, Carnegie Inst. of Tech.

The Pittsburgh Program in Retrospect—The Economic Evaluation, by *Adolph Schmidt*, Allegheny Conference on Community Development

Pittsburgh Looks to the Future—Research Program, by *C. A. Bishop*, Mem. AIChE, U. S. Steel Corp., and *W. W. Campbell*, Mem. AIChE, U. S. Steel Corp.

Dinner **7:30 p.m.**

Presiding: *Walton Forstall*, Chairman, ASME Pittsburgh Section, professor of mechanical engineering, Carnegie Inst. of Tech.

Toastmaster: *A. L. Bayles*, Mem. ASME, Allison L. Bayles and Associates, Consulting Engineers

Honors: To be announced

Speaker: *W. L. Faith*, managing director, Air Pollution Foundation, San Marino, Calif.

Subject: **Air-Pollution Problems in Los Angeles and Their Solution**

▶TUESDAY, APRIL 21

Technical Sessions and Inspection Trip **10:00 a.m.**

Location: Frank R. Phillips Power Station, Duquesne Light Co., South Heights opposite Ambridge, Pa.

Chairman: *E. M. Parrish*, general superintendent, Power Stations Department, Duquesne Light Co.

Vice-Chairman: *G. E. Dignan*, Mem. ASME, Consulting engineer, Pittsburgh Coke and Chemical Co.

Air Pollution Problems and Their Solution in a Pulverized-Coal Burning Steam-Generating Station, by *C. C. Munn*, Mem. AIEE, Duquesne Light Co.

Blast-Furnace Gas Cleaning for Iron and Ferromanganese Production, by *J. S. Mackay*, Mem. AIChE, and *J. F. Kearns*, Mem. AIChE, Pittsburgh Coke and Chemical Co., Neville Island, Pittsburgh

Inspection: Frank R. Phillips Power Station 11:30 a.m.

Luncheon: Dravo Cafeteria, Guests of Dravo Corp. 1:30 p.m.

Inspection: Pittsburgh Coke and Chemical Co. 2:45 p.m.

Neville Island Plant

Embark on *Gateway Clipper* for boat trip to Pittsburgh 4:30 p.m.

The new Allegheny County Sanitary Authority Sewage-Treatment plant will be discussed and viewed en route. Due to arrive at hotel by 6:00 p.m.

ASME Design Engineering Conference in Philadelphia to Be Held Concurrently With Design Engineering Show, May 25–28

Sessions on Materials in Design, Mechanical Aspects of Design, Power and Control highlight technical program

Sessions devoted to the choice of materials in design, mechanical aspects of design, and power and control in design will be featured at the fourth annual Design Engineering Conference, sponsored by the Machine Design Division of The American Society of Mechanical Engineers in co-operation with the ASME Philadelphia Section.

The conference will be held concurrently with the Design Engineering Show, produced by Clapp & Poliak, Inc., of New York City. Both events will take place at Convention Hall, Philadelphia, Pa., May 25–28, inclusive, with conference sessions scheduled in the morning and the show held from noon to 5:30 p.m. every day except Tuesday, May 26, when the hours will be noon to 9:30 p.m.

Design Engineering Show

The show is devoted to research and development for industry. Exhibits include products which aid in the design of new end products. Among the exhibits will be mechanical components of various kinds, power-transmission equipment, electrical and electronic components, metals and nonmetallic materials, fasteners and adhesives, finishes and coatings, shapes and forms, hydraulic and pneumatic components, and engineering equipment and service, as well as publications.

More than 400 companies will exhibit. Visitors from virtually every major manufacturing and processing company in the country will attend.

Technical sessions on materials, mechanics, and power and control will run concurrently during the second and third days, but there will be two general sessions on the first and last days of the conference.

The first day's general session will be devoted to the education of engineers. A paper delivered by Hellmuth Walter, Mem. ASME, R&D director, Worthington Corporation, Harrison, N. J., on "Engineering Design in Germany," will describe the technical education of German engineers. The paper also takes up the role of the engineering executive in German industry, the loss of German engineering talent to the USSR, and the relationship of engineering to other phases of industry.

The general session on the fourth day will consider general design-engineering problems and the effective use of engineers. E. M. Ramberg, Assoc. Mem. ASME, vice-president—engineering, and R. P. Dominic, Assoc. Mem. ASME, his assistant, of Titeflex, Inc., Springfield, Mass., will deliver a paper on "A Graphic Method for Engineering Organization," which will define shortcomings in engineering organizational charts in companies of all sizes. Another paper, "The Man and the Organization," by M. M. Bruce, vice-president and director, psychological services, Clark, Channell, Inc., Stamford, Conn., will discuss the objectives on which management is built and the needs on which personal adjustment is built, with a suggested organizational structure to meet management and individual needs.

ASME Papers By Mail

Papers to be presented at Sessions 2 through 8 are available in separate copy form until Feb. 1, 1960. Copies can be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. The papers are priced at 40 cents each to members of ASME and 80 cents to nonmembers. Payment may be made in U. S. currency or ASME coupons. Papers must be ordered by the paper numbers listed in the program otherwise the order will be returned.

▶MONDAY, MAY 25

Registration **8:00 a.m.**

Session 1, Engineering Design Overseas **10:00 a.m.**

Co-Chairmen: *J. W. Barker*, chairman of the board (ret), Research Corp., New York, N. Y.

C. W. Besserer, assistant program director, Minuteman Program, Space Technology Labs., Los Angeles, Calif.

Engineering Design in Germany, by *Hellmuth Walter*, director of research, Worthington Corp., Harrison, N. J.

▶TUESDAY, MAY 26

Registration **8:00 a.m.**

Session 2, Materials **9:30 a.m.**

Co-Chairmen: *J. C. Redmond*, consultant, Pittsburgh, Pa.

R. N. Peterson, supervisor, application design group, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Latest Developments in Plastics for High-Temperature Service, by *I. J. Gruntfest*, Gen. Elec. Co., Philadelphia, Pa.

Latest Developments in Metals and Ceramics for High-Temperature Service, by *J. J. Harwood*, Office of Naval Research, Department of the Navy, Washington, D. C. (Paper No. 59—MD-2)

Session 3, Power and Control **9:30 a.m.**

Co-Chairmen: *D. G. Durcher*, chief electrical engineer, Hanson-Van Winkle-Munning Co., Matawan, N. J.

R. W. Barnitz, chief electrical engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Variable Speed D-C Drive Systems, by *M. H. Sluis*, Pratt & Whitney Co., Inc., West Hartford, Conn. (Paper No. 59—MD-3)

D-C Conversion Devices, by *J. J. Rheinhold*, Richardson-Allen Corp., College Point, N. Y. (Paper No. 59—MD-4)

Session 4, Mechanical 9:30 a.m.

Co-Chairmen: *F. L. Jackson*, technical director, The Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

T. R. Rideout, consulting engineer, Port Chester, N. Y.

Design and Application of Belts, Chains, and Gears, by *E. S. Cheaney, W. C. Raridan,* and *C. L. Paullus*, Product Development Div., Battelle Memorial Inst., Columbus, Ohio (Paper No. 59—MD-5)

Clutch-Fluid Coupling-Torque Converter, Application Considerations, and Performance Comparisons, by *R. W. Bachmann*, Hydraulic Div., Twin Disc Clutch Co., Rockford, Ill. (Paper No. 59—MD-6)

▶WEDNESDAY, MAY 27

Registration 8:00 a.m.

Session 5, Materials 9:30 a.m.

Co-Chairmen: *E. H. Phelps*, assistant division chief, Chemical-Metallurgy Div., Applied Research Lab., U. S. Steel Corp., Monroeville, Pa.

R. V. Vanden Berg, head, Finishes Section, process development labs., Aluminum Co. of America, New Kensington, Pa.

Latest Developments in Materials to Resist Chemical Corrosion, by *S. W. Shepard*, Chemical Construction Corp., New York, N. Y. (Paper No. 59—MD-7)

Latest Developments in Materials and Coatings to Resist Atmospheric Corrosion, by *E. B. Friedl*, Corrosion Research Div., *L. J. Nowacki*, Organic Coatings Research, and *W. H. Safranek*, Electrochemical Engineering Div., Battelle Memorial Inst., Columbus, Ohio (Paper No. 59—MD-8)

Session 6, Power and Control 9:30 a.m.

Co-Chairmen: *J. W. Picking*, manager, Control Div., Reliance Electric and Engineering Co., Cleveland, Ohio

A. M. Kimball, manager, Digital Control Engineering, director systems dept., Westinghouse Elec. Corp., Pittsburgh, Pa.

Digital Systems for Control Applications, by *I. L. Auerbach*, Auerbach Electronics Corp., Narberth, Pa. (Paper No. 59—MD-9)

Logic Circuits for Machine Control, by *E. V. Weir*, Magnetics, Inc., Butler, Pa. (Paper No. 59—MD-10)

Session 7, Mechanical 9:30 a.m.

Co-Chairmen: *Dudley Fuller*, professor, mechanical-engineering dept., Columbia Univ., New York, N. Y.

Stanley Abramovitz, Continental Bearing Research Corp., New York, N. Y.

Design Curves for Journal Bearings, by *D. F. Hays*, mechanical-development dept., research labs, General Motors Corp., Warren, Mich. (Paper No. 59—MD-11)

Which Bearing and Why, by *A. O. DeHart*, mechanical-development dept., research labs, General Motors Corp., Warren, Mich. (Paper No. 59—MD-12)

▶THURSDAY, MAY 28

Registration 8:00 a.m.

Session 8, General Engineering 9:30 a.m.

Co-Chairmen: *T. W. Hopper*, president and director, Day & Zimmermann, Inc., Philadelphia, Pa.

G. L. Broomell, director of engineering, Leeds & Northrup Co., Philadelphia, Pa.

A Graphic Method for Engineering Organization, by *E. M. Ramberg*, Titeflex, Inc., Springfield, Mass. (Paper No. 59—MD-13)

The Man and the Organization, by *M. M. Bruce*, Clark, Channell, Inc., Stamford, Conn. (Paper No. 59—MD-14)

ASME, AIEE, IRE Join to Report Progress in Automation

A CONFERENCE to explain and evaluate the use of automatic controls in such diverse applications as banking, steel manufacture, sorting of mail, and railroading will be held at the Pike Congress Hotel, Chicago, Ill., May 11–13. It will be sponsored jointly by The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Institute of Radio Engineers.

This, the second annual joint Conference on Automatic Techniques, will avoid the complex engineering problems usually associated with automation. It will cover instead progress now being made in automatic controls and ways in which they may be applied to any industry.

Details of the advance program follow:

▶MONDAY, MAY 11

Automatic Techniques in Steelmaking 9:30 a.m.

Application of Data Logging and Programming Techniques to Steel-Mill Process, by *R. W. Barnitz*, Jones & Laughlin Steel Corp., Pittsburgh, Pa., and *G. E. Terwilliger*, General Electric Co., Schenectady, N. Y.

Shaping Steel in a Programmed Mill, by *H. G. Frostick*, U. S. Steel Corp., Chicago, Ill.

Productivity Improvement Through Automatic Control Techniques, by *C. Zimmermann*, American Steel and Wire Div., U. S. Steel Corp., Worcester, Mass.

Automatic Techniques in Manufacturing 2:00 p.m.

Financial Justification of Automatic Machines, by *W. W. Kuyper*, General Electric Co., Schenectady, N. Y.

Application of Numerical Control for Automatic Manufacturing in General Industry, by *W. E. Brainard*, Kearney & Trecker Corp., Milwaukee, Wis.

Static Control and Automatic Transmissions, by *C. N. Bell* and *Ivan Hosek*, Ford Motor Co., Cincinnati, Ohio

▶TUESDAY, MAY 12

Automatic Business Data Handling 9:30 a.m.

Automatic Techniques in Banking, by *B. W. Taunton*, First National Bank of Boston, Boston, Mass.

High-Speed Bank Automation, by *Warren Price*, General Electric Co., Phoenix, Ariz.

Data Processing—Its Role in Administration, by *J. D. Gallagher*, Sylvania Electric Products, Inc., Camillus, N. Y.

Automatic Techniques in Sorting and Handling 2:00 p.m.

Automation in Railroading, by *V. E. McCoy*, Chicago, Milwaukee, St. Paul & Pacific Railroad Co., Chicago, Ill.

Mail-Flo System Speeds the Mail, by *S. C. Skeels*, Office of Research & Engineering, U. S. Post Office Department, Washington, D. C.

Mechanization of the Job Shop, by *W. Willetts*, Western Electric Co., Inc., North Andover, Mass.

▶WEDNESDAY, MAY 13

Automatic Techniques in the Processing Industries 9:30 a.m.

Data Gathering and Continuous Chemical Processing, by *P. D. Schnelle*, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Use of Data Logging in Chemical Processing, by *G. P. Russell*, Monsanto Chemical Co., Nitro, W. Va., and *T. J. Shuff*, Monsanto Chemical Co., St. Louis, Mo.

An Optimizing Control for the Processing Industries, by *D. A. Burt*, Westinghouse Electric Corp., East Pittsburgh, Pa.

Plant Visit 2:00 p.m.

Detroit, World-Famous Production Center, Welcomes ASME National Production Engineering Conference

THE Production Engineering Division of The American Society of Mechanical Engineers, with the co-operation of the ASME Detroit Section, will be host to the 1959 ASME National Production Engineering Conference to be held May 12–14 at the Statler Hilton Hotel, Detroit, Mich.

The theme of this year's conference is "Engineering for Productivity." The technical sessions will develop individually the product, the processes and equipment, and the organization and management.

Several inspection trips are planned to include the facilities of the "Big 3"; namely, The Ford River Rouge plant, Plymouth Engine plant, and General Motors Technical Center.

▶MONDAY, MAY 11

Registration and "Early Bird" Party 5:30 p.m.–8:30 p.m.

▶TUESDAY, MAY 12

Session 1, General Session 9:00 a.m.

Chairman: *N. L. Bean*, technical assistant to vice-president—manufacturing, Ford Motor Co., Livonia, Mich.

Vice-Chairman: *W. C. Truckenmiller*, assistant technical director, Albion Malleable Iron Co., Albion, Mich.

Facets of Productivity,[1] by *H. B. Miller*, General Electric Co., New York, N. Y.

Measurement of Productivity,[1] by *J. W. Kendrick*, George Washington Univ.

Product Luncheon 11:45 a.m.

Speaker: *Richard S. Latham*, partner, Latham, Tyler, Jensen Design, Chicago, Ill.

[1] Paper not available—see box on page 136.

Subject: **Industrial Design Trends Affecting Engineering for Productivity**

Inspection Trip **1:30 p.m.**

Ford River Rouge Plant

▶WEDNESDAY, MAY 13

Session 2, Product **9:00 a.m.**

Chairman: *M. E. Salveson*, Center for Advanced Management, New Canaan, Conn.

Vice-Chairman: *H. M. Hess*, associate dean, College of Engineering, Wayne State Univ.

Operations Research in Product Design,[1] by *J. W. McBride*, Applied Research Operation, General Electric Co., Evandale, Ohio

Computers as a Tool in Product Engineering,[1] by *C. R. De Carlo*, International Business Machines Corp., New York, N. Y.

Session 3, Organization **9:00 a.m.**

Chairman: *W. H. Friedlander*, manager, Product Engineering, Curtiss-Wright Corp., Quehanna, Pa.

Vice-Chairman: *G. D. Uicker*, acting chairman, Department of Mechanical Engineering, Univ. of Detroit

Central Stores and Dispatch Systems in Relation to Productivity,[1] by *W. P. Dugan*, Western Electric Co., Inc., North Andover, Mass.

Management Implications of Production Controls,[1] by *V. C. Peterson*, Western Electric Co., Inc., North Andover, Mass.

Session 4, Processes **9:00 a.m.**

Chairman: *E. A. Reed*, industrial engineering, General Motors Inst., Flint, Mich.

Vice-Chairman: *Joseph Datsko*, Department of Mechanical Engineering, Univ. of Michigan

Electrical Discharge Machining of Metals,[1] by *Albert Holm*, Elox Corp. of Michigan, Royal Oak, Mich.

Chipless Forming of Toothed Parts by Rolling,[1] by *Harry Pelphrey*, Michigan Tool Co., Detroit, Mich.

Shear Spinning,[1] by *B. N. Colding*, Cincinnati Milling Machine Co., Cincinnati, Ohio (To be presented by *Serope Kalpakcioglu*, Cincinnati Milling Machine Co.)

Organization Luncheon **12:00 Noon**

Speaker: *T. E. Shea*, Vice-President, Engineering Division, Western Electric Co., Inc., New York, N. Y.

Subject: **Untapped Sources of Productivity**

Session 5, Product **2:00 p.m.**

Chairman: *A. O. Schmidt*, Research, Kearney and Trecker, Milwaukee, Wis.

Vice-Chairman: *G. H. Martin*, professor, Department of Mechanical Engineering, Michigan State Univ.

An Operations Research Approach to In-Process Inventories,[1] by *J. H. Roseboom*, Booz-Allan-Hamilton Management Consultants, Chicago, Ill.

Product-Reliability Measurement,[1] by *D. L. Flanders*, Allison Div., General Motors Corp., Indianapolis, Ind.

Process Analysis Via Simulation,[1] by *R. W. Metzger*, General Motors Inst., Flint, Mich.

[1] Paper not available—see box on this page.

Session 6, Organization **2:00 p.m.**

Chairman: *R. H. McCarthy*, director of plant engineering, Western Electric Co., Inc., New York, N. Y.

Vice-Chairman: *J. Q. Holmes*, director of production engineering, Process Development Staff, General Motors Corp., Detroit, Mich.

Reliability of Productivity Increases,[1] by *D. C. Burnham*, Westinghouse Electric Corp., Pittsburgh, Pa.

Production of What for What,[1] by *K. E. Boulding*, Univ. of Michigan

Session 7, Processes **2:00 p.m.**

Chairman: *N. F. Snyder*, industrial engineering, General Motors Inst., Flint, Mich.

Vice-Chairman: *J. Frederick*, assistant professor of engineering, Univ. of Michigan

Application of Numerical Control to Manufacturing,[1] by *Peter Rusnov*, Warner & Swasey Co., Cleveland, Ohio

Numerical Control for Machine Tools,[1] by *H. J. Palmer*, General Electric Co., Waynesboro, Va.

Economics of Numerical Control,[1] by *E. E. Kirkham*, Pratt and Whitney Co., West Hartford, Conn.

Social Hour **6:30 p.m.**

Banquet **7:00 p.m.**

Speaker: *Robert M. Critchfield*, vice-president, Process Development Staff, General Motors Corp., Detroit, Mich.

Subject: **Manufacturing Challenges**

▶THURSDAY, MAY 14

Session 8, Organization and Management **9:00 a.m.**

Chairman: *Leif Fersing*, Jones and Lamson, Springfield, Vt.

Vice-Chairman: *R. O. Lane*, vice-president, Macklin Co., Jackson, Mich.

Statistical Process Evaluation as a Management Tool,[1] by *J. M. Brown*, Western Electric Co., Inc., Princeton, N. J.

Productivity Looked at Outside Industry,[1] by *S. I. Paradise*, Reverend, Detroit Industrial Mission, Detroit, Mich.

Session 9, Processes and Equipment **9:00 a.m.**

Chairman: *M. E. Merchant*, director of physical research, Cincinnati Milling Machine Co., Cincinnati, Ohio

Vice-Chairman: *W. H. Churchill*, professor, Department of Manufacturing Processes, Wayne State Univ.

Shear-Zone Size, Compressive Stress, and Shear Strain in Metal Cutting and Their Effect on Mean Shear-Flow Stress,[1] by *Dimitri Kececioglu*, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Influence of Surface Residual Stress on the Fatigue Limit of Titanium,[1] by *E. C. Reed*, Pratt and Whitney Aircraft Div., United Aircraft Corp., East Hartford, Conn.

Review of Technical Literature on Metal Cutting—1958 Metal-Cutting Analysis,[1] by *E. G. Thomsen*, Univ. of California, Berkeley

Cutting Fluids,[1] by *H. A. Erickson*, D. A. Stuart Oil Co., Ltd., Chicago, Ill.

Metal-Cutting Practice,[1] by *G. P. Witteman*, Bethlehem Steel Co., Bethlehem, Pa.

Grinding,[1] by *George Reichenbach*, M.I.T.

Plastic Working of Metals,[1] by *F. W. Boulger* Battelle Memorial Inst., Columbus, Ohio

Processes and Equipment Luncheon **11:45 a.m.**

Speaker: *Ralph Cross*, executive vice-president, The Cross Co., Detroit, Mich.

Subject: **Planning for Automation**

Inspection Trips **1:45 p.m.**

Plymouth Engine Plant

General Motors—Technical Center

ASME Papers by Mail

ONLY *numbered* ASME papers will be available in separate copy form until March 1, 1960. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N.Y. Prices are 40 cents each to members of ASME; 80 cents each to nonmembers. Papers must be ordered by the paper numbers, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

ASME Applied Mechanics Conference to Be Held June 18–20 at Virginia Polytechnic Institute

THE national conference of the Applied Mechanics Division of The American Society of Mechanical Engineers will be held on June 18–20, 1959, at the Virginia Polytechnic Institute, Blacksburg, Va.

The conference, cosponsored by the ASME Virginia Section, will discuss elasticity, plasticity, and vibrations and hydrodynamics during the technical sessions. The papers will be presented by outstanding authorities in the field of applied mechanics. The conferees will hear opinions and learn of developments not only from the United States, but from England, Australia, Japan, and China as well.

▶THURSDAY, JUNE 18

Registration **8:00 a.m.**

Session 1, Elasticity **2:00 p.m.**

On Inertia Effects in a Transient Thermoelastic Problem, by *E. Sternberg* and *J. G. Chakravorty*, Brown Univ.

Thermal Stresses in Moderately Thick Elastic Plates, by *B. E. Gatewood*, director, Air Force Inst. of Tech.

Analysis of Plane Stress in Polar Co-ordinates and With Varying Thickness, by *H. D. Conway*, Ohio State Univ.

The Stress Distribution in a Semi-Infinite Strip Subjected to a Concentrated Load, by *P. S. Theocaris*, Brown Univ.

The Stress Function of a Radial Strain, by *F. Goded*, General Electric Española, Madrid, Spain

On Invariant Perforation in an Infinite Strip, by *Chih-Bing Ling*, Aeronautical Research Lab., Taichung, Taiwan, Formosa, China

Note on a Thermoelectric Problem for a Transversely Isotropic Hollow Sphere Embedded in an Elastic Medium, by *J. Nowinski*, Univ. of Wisconsin

Kick-Off Party for Members and Wives **7:00 p.m.**

▶FRIDAY, JUNE 19

Registration **8:00 a.m.**

Session 2, Elasticity **9:00 a.m.**

Piping Flexibility Analysis by Stiffness Matrix, by *L. H. Chen*, General Dynamics Corp.

On the Accuracy of Some Shell Solutions, by *J. R. M. Radok* and *G. D. Galletly*, Shell Development Co.

A New Theory of Electric Sandwich Plates—One-Dimensional Case, by *Yi-Yuan Yu*, Polytechnic Inst. of Brooklyn

Displacements and Stresses of a Laterally Loaded Semicircular Plate With Clamped Edges, by *W. H. Jurney*, Colorado School of Mines

On Finite Bending of Pressurized Tube, by *Eric Reissner*, M.I.T.

Session 3, Plasticity **2:00 p.m.**

The Determination of Safe Loads of Beams

Subjected to Combined Twisting and Biaxial Bending Moments, by *P. G. Hodge, Jr.*, and *R. Sankaranarayanan*, Illinois Inst. of Tech.

Carrying Capacity of Elastic Plastic Shells With Various End Conditions, Under Hydrostatic Compression, by *Burton Paul*, Brown Univ.

Incremental Stress-Strain Law Applied to Work-Hardening Plastic Materials, by *Chintsun Huang*, National Cash Register Co., Hawthorne, Calif.

Creep of Thick-Walled Tubes Under Internal Pressure Considering Large Strains, by *F. P. J. Rimrott*, Pennsylvania State Univ.

Triaxial Tension at the Head of a Rapidly Running Crack in a Plate, by *J. M. Frankland*, N.B.S., Engineering Mechanics, Washington, D. C.

On the Instability and Folding Deformation of a Layered Viscoelastic Medium in Compression, by *M. A. Biot*, New York, N. Y.

Social Hour 5:30 p.m.

Dinner 6:30 p.m.

▶SATURDAY, JUNE 20

Registration 8:00 a.m.

Session 4, Vibrations and Hydrodynamics 9:00 a.m.

Extensional Vibrations of Elastic Plates, by *R. D. Mindlin* and *M. A. Medick*, Columbia Univ.

On Supersonic Wind Tunnels With Free-Stream Disturbances, by *M. V. Morokovin*, School of Engineering, John Hopkins Univ.

Upper and Lower Bounds for Special Eigenvalues by *F. C. Appl*, Tulsa, Okla., and *C. F. Zorowski*, Carnegie Inst. of Tech.

Vibration of Beam-Mass Systems With Time-Dependent Boundary Conditions, by *C. T. Yen*, The Franklin Inst. Lab., Philadelphia, Pa., and *Shou Kao*, M. W. Kellogg Co., New York, N. Y.

Analysis of a Nonlinear Mechanical System With Three Degrees of Freedom, by *S. A. Hovanessian*, California Research Corp., La Habra Lab., La Habra, Calif.

A Theory of Oil Whip, by *Y. Hori*, University of Tokyo, Tokyo, Japan

The Frequency of Flexural Vibration of Rectangular Orthotropic Plates With Clamped or Supported Edges, by *R. F. S. Hearmon*, Aylesbury, Bucks., England

On Critical Speeds of a Shaft Supported by a Ball Bearing, by *Toshio Yamamoto*, Nagaya Univ., Nagaya, Japan

Symmetric Vortex Separation on Circular Cylinders and Cones, by *A. E. Bryson*, Harvard Univ.

The Drag on Spheres and Cylinders in a Stream of Dust-Laden Air, by *T. Gillespie* and *A. W. Gunter*, Dow Chemical Co., Midland, Mich.

Density Variation Effects in Step-Thrust Bearings, by *C. F. Kettleborough*, Univ. of Auckland, Auckland, New Zealand

Viscous Flow Through Tubes of Multiple Connected Cross Section, by *F. A. Gaydon* and *H. Nuttall*, Univ. of Bristol, Bristol, England

ASME Boiler and Pressure Vessel Committee to Meet, June 1–3

THE Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers holds six meetings a year; one of which is held out of New York City. The 1959 meeting will be held June 1 to June 3, 1959, inclusive, at the Palliser Hotel, Calgary, Alta., Canada. A meeting of The National Board of Boiler and Pressure Vessel Inspectors will be held prior to the Code Committee Meeting at Vancouver, B. C., Canada, May 25 to 28, inclusive, at the Georgia Hotel. Meeting dates of these groups have been co-ordinated to permit those attending the Vancouver meeting to proceed directly to the Boiler and Pressure Vessel Committee Meeting at Calgary.

Meetings will be held of the various subcommittees covering in part, power and heating boilers, unfired pressure vessels, nondestructive testing, and welding. The afternoon sessions of the Subcommittees on Heating Boilers and Unfired Pressure Vessels will be of the panel-session type.

A banquet will be held on Tuesday evening and the all-day session of the Boiler and Pressure Vessel Committee is planned for Wednesday. Meetings of the various subcommittees as well as the Boiler and Pressure Vessel Committee are open to the public.

Representatives from the Boiler and Pressure Vessel Committee and the Engineering Institute of Canada comprise the Planning Committee.

ASME Center at International Petroleum Exposition

ASME visitors to the International Petroleum Exposition will have a special Center in which to register and to get information about other ASME members attending the Tulsa, Okla., oil show, May 14–23.

"Signs at all entrances will remind ASME members to register and use the Center to locate their friends and associates," Edward A. Lyle, registration committeeman from the Mid-Continent Section said. "If members make it a point to register, we believe it will make their visit to the IPE more profitable and pleasant," he added.

The Mid-Continent Section has joined with 16 other societies to sponsor the IPE Technical Societies' Registration Center for all engineers and technical men. The Center is to be in The Petroleum Engineer Publishing Company exhibit located at Texas and Mid-Continent Drive near the exposition grounds' main entrance.

ASME Air Pollution Controls Committee Moves to Help Stamp Out Scourge

A MOVE to help towns, counties, and states deal with the ever-growing problem of air pollution was launched recently by the Committee on Air Pollution Controls of The American Society of Mechanical Engineers.

This effort is to be a review and modernization of the ASME Model Smoke Ordinance. The present document has been used as the basis for numerous municipal smoke and fly-ash ordinances since it was published in 1949. Now it is to be brought up to date in its limitations on smoke and fly ash as viewed from a practical, engineering viewpoint. Eventually a new model ordinance will be developed which will cover not only smoke and ash but the many new pollutants which are now contaminating the air, as well.

In part, ASME's concern with air pollution has stemmed from its interest in fuels and in combustion processes. The present Model Smoke Ordinance, developed by ASME members, which has met with wide acceptance, stemmed from earlier efforts in the U. S. Bureau of Mines.

"The new model will meet the needs of the modern problem," stated G. V. Williamson, Mem. ASME, chairman of the ASME Committee on Air Pollution Controls. "It will encourage patience in many communities and possibly prevent them from rushing into unwise legislation not suitable for their specific local problems." Mr. Williamson, a vice-president of Union Electric Company of Missouri, is one of the nation's outstanding authorities on air pollution.

Members of the "nucleus" review committee include representatives from governmental, industrial, research, and trade association groups. Named by the organizing committee were Dr. C. A. Bishop of the U. S. Steel Company; R. A. Van Meter of the U. S. Bureau of Mines; Leo Flood, Mem. ASME, of the New York City Department of Air Pollution Control; E. H. Man, Mem. ASME, of the Consolidated Edison Company; Dr. R. A. Glenn of Bituminous Coal Research, Inc.; O. F. Campbell, Mem. ASME, of the Sinclair Refining Company; Robert L. Chass of the Los Angeles County Air Pollution Control District; F. J. Leonhard, Mem. ASME, of the Cleveland Electric Illuminating Company; Samuel M. Rogers of the U. S. Public Health Service; and A. N. Heller of the Allied Chemical Corporation.

Louis A. Winkelman, Mem. ASME, of the Public Service Electric and Gas Company, was named as a liaison member.

The first committee meeting was held February 11 at the Engineering Societies Building in New York.

Steam Research at Caltech Under ASME Aegis

THE American Society of Mechanical Engineers Research Committee on Properties of Steam is carrying out two major functions —(*a*), direction of the steam research program in this country; and (*b*), assisting ASME in discharging its responsibilities as Secretariat for coordinating work on the international scene.

As part of a $350,000 program sponsored by the Society, engineers at California Institute of Technology, Pasadena, Calif., are working to extend the international steam tables. The U. S. Commission on the Properties of Steam is co-operating.

Caltech engineers are pushing steam up to new high pressures and temperatures in an attempt to squeeze more useful energy and greater efficiencies from this prime source of the world's industrial power.

Bottled in a red-hot chrome-steel chamber in a Caltech laboratory, steam is gradually being heated to an ultimate high of about 1500 F and 15,000 psi. Present top operating levels in industry are about 1000 F and 3000 psi, although the averages are much lower.

"With higher pressures we can use smaller equipment," explained Dr. Bruce H. Sage, codirector of Caltech's chemical engineering laboratory. "And with higher temperatures we get higher efficiencies—or more electricity per pound of oil in a steam-power plant."

Dr. George N. Richter, assistant professor of chemical engineering, said other engineers are interested in the development of smaller steam-power units for nuclear engines such as are used in submarines, where the space factor and efficiency are vital.

Caltech's role in the international project is to study the behavior of steam at various extreme temperatures and pressures. The results are reduced to sets of figures which comprise what are known as the international steam tables. The tables are used in the design of boilers, turbines, and heat-exchange units of nuclear reactors.

Existing international tables compiled in 1936 are based on data that only go up to 850 F and 5000 psi. Engineers are beginning to build equipment for steam that goes beyond these figures.

Under the international study, Russian engineers also are extending the tables, but are using a different method. Russia is doing considerably more research than this country in steam, Dr. Sage said, because she is pushing the development of power.

The Caltech study has been under way four years and may be completed by the end of this year. The engineers have learned that as pressures and temperatures increase, steam becomes increasingly corrosive to steels. This is partly due to the fact that some of the steam decomposes into oxygen and hydrogen. And the oxygen quickly blackens the steel chamber wall.

Dr. Sage suggested lining the chamber with gold, which does not oxidize. However, the cost would be $10,000.

"We hope," said Dr. Richter, "that the metallurgists will come up with something so that we do not have to use gold-plated boilers."

Dr. Sage said that the investigation has been slowed more than was expected by metallurgical problems. Research in metals to resist oxidation by high-temperature steam has been in the direction of chrome-nickel steels, he added.

At present, Caltech engineers are studying steam in the range of 800 to 1000 F and at 7000 psi and a little above. Several metals are being tested at the same time for corrosive-resistant qualities.

Steam is observed at each temperature for about a month and then the temperature is elevated 100 F and the study is resumed.

To do the job, the engineers have built a massive, intricate steam-temperature measuring device called a calorimeter. It is massive so that it won't fail. It consists of two chambers, one inside the other, to enable it to withstand the pressures.

Between the two chambers is a "wall" of helium gas, whose pressure is maintained equal to that of the steam in the inner chamber. Helium pressing inward prevents the red-hot inner chamber from expanding outward. The inner chamber is 22 in. tall by 8 in. in diam and the outer one—which has 5 in. thick walls—is 23 in. in diam by 54 in. long. Electric coils put heat into the inner chamber. Oil circulating in pipes coiled around the outer chamber carries off excess heat and thus maintains an even temperature.

An eight-stage centrifugal pump, with heat-resistant titanium carbide bearings, forces the superheated steam through its cycle. The steam moves slowly through a porous, thimble-shaped piece of aluminum oxide which, like gold, does not tarnish when in contact with steam. It is near the thimble that temperature and pressure-measuring instruments are located. Attempts are made to measure the temperature within an accuracy of 0.0005 of a degree.

All stressed parts of the calorimeter are of steel. Gaskets are of gold alloy and platinum, except for one or two that are of copper. These metals were chosen for their corrosion resistance. The calorimeter uses distilled water with less than one part of impurity per million parts of water.

"We don't think we will find any unexpected properties of steam," Dr. Sage said. "So far, we are finding nearly the properties that we expected from earlier estimates."

How Well Do You Know Your Society?

SO THAT the members of ASME may know their Society attention is called to the list of Manuals and Annuals available upon request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Unless otherwise noted all the items in the list will be sent without charge.

AC 2	Annual Report of ASME Research
AC 10	Personnel of Council, Boards, and Committees
AM 1	Membership List—Alphabetical and Geographical (Biennial—odd-numbered years)
AM 3	Catalog of Publications (also included in "Mechanical Catalog")
AM 4	Members List—Listed by Companies (Biennial—even-numbered years, $2 each)
AM 5	Indexes to ASME Papers and Publications (Published annually in January as part of *Transactions of ASME*)
MM 1	Certificate of Incorporation, Constitution, By-Laws, and Rules
MM 2	Know Your Society
MS 4	An ASME Paper (50 cents to nonmembers)
MS 61	Citizenship and Participation in Public Affairs

Correction

FIGS. 17 and 18 were reversed in the article on "Progress in Railway Engineering," in the February, 1959, issue, p. 71. The locomotive reproduced as Fig. 18 should be Fig. 17 and vice versa.

ASME COMING EVENTS

April 5–10
Nuclear Congress, Cleveland Auditorium, Cleveland, Ohio

April 8–9
ASME-AIEE Railroad Conference, Sheraton Hotel, Chicago, Ill.

April 13–15
ASME Hydraulics Conference, University of Michigan, Ann Arbor, Mich.

April 19–23
ASME Oil and Gas Power Conference, Shamrock Hilton Hotel, Houston, Texas

April 23–24
ASME Management-SAM Conference, Statler Hilton Hotel, New York, N. Y.

April 29–May 3
ASME Metals Engineering Conference, Sheraton-Ten Eyck Hotel, Albany, N. Y.

May 4–5
ASME Maintenance and Plant Engineering Conference, Edgewater Beach Hotel, Chicago, Ill.

May 12–14
ASME Production Engineering Conference, Statler Hilton Hotel, Detroit, Mich.

May 25–28
ASME Design Engineering Conference, Convention Hall, Philadelphia, Pa.

June 1–3
ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting, Palliser Hotel, Calgary, Alberta, Canada

June 14–18
ASME Semi-Annual Meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

June 18–20
ASME Applied Mechanics Conference, Virginia Polytechnic Institute, Blacksburg, Va.

August 9–12
ASME-AIChE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

September 9–11
ASME Applied Mechanics Western Conference, Stanford University, Stanford, Calif.

September 10–12
ASME Wood Industries Conference, Multnomah Hotel, Portland, Ore.

September 17–18
ASME-AIEE Engineering Management Conference, Statler Hilton Hotel, Los Angeles, Calif.

September 20–23
ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas

September 27–October 1
ASME-AIEE National Power Conference, Hotel Muehlebach, Kansas City, Mo.

October 20–22
ASME-ASLE Lubrication Conference, Hotel Sheraton-McAlpin, New York, N. Y.

October 26–29
ASME-AIME Fuels Conference, Netherland Hilton Hotel, Cincinnati, Ohio

November 4–6
ASME-IRE-AIEE-ISA National Automatic Control Conference, Sheraton Hotel, Dallas, Texas

November 29–December 4
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

(For Meetings of Other Societies, see page 130)

NOTE: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N.Y., for which there is no charge providing you state that you are a member of ASME.

Analog and Digital Instrumentation Conference, April 20-21, Philadelphia, Pa.

THE third national conference on Analog and Digital Instrumentation, sponsored by the Recording and Controlling Instrumentation Committee of the American Institute of Electrical Engineers, will be held April 20-21 at the Bellevue-Stratford Hotel, Philadelphia, Pa.

The ASME Instruments and Regulators Division along with the Institute of Radio Engineers and the Instrument Society of America are the co-operating societies.

The technical program, to be presented in seven sessions, will cover engineering education for instrumentation, electronic analog recorders, computer control systems, data-handling systems for industrial processes, electrical transducer systems for electric control, high-speed data handling and processing, and electronic systems for process control.

SAM-ASME Management Engineering Conference, April 23-24

THE fourteenth annual Management Engineering Conference, sponsored by the Society for Advancement of Management and the Management Division of The American Society of Mechanical Engineers, will be held April 23 and 24 at the Statler Hilton Hotel, New York City.

The meeting is designed to develop means toward "Profitable Management Engineering—1959" and the theme will be covered as follows: Practical cost reduction, advanced tools for today's decisions, improving management productivity, personal development of industrial engineers, the role of labor in productivity, new approaches to using and maintaining standards, optimizing the solution of production-control problems, and work measurement and incentives.

In the course of the meeting, the discussion will bring up to date the vast amount of theory and practice which business and industry can use to improve their current operations and should uncover new possibilities of profit improvement.

ASME-AIChE Agreement

TO HELP engineers obtain up-to-date information, two of the nation's leading engineering societies have agreed to offer certain publications to members of the other group at substantial discounts in price.

In the future, members of the American Institute of Chemical Engineers may purchase subscriptions to the *Journal of Heat Transfer*, published by The American Society of Mechanical Engineers, at the same price as it is offered to ASME members, $5 per year, one half the nonmember rate.

Reciprocally, ASME members may purchase AIChE volumes on Heat Transfer in its Monograph and Symposium Series at the same rates offered to AIChE members.

The reciprocal agreement was announced jointly by the two societies and will extend for a trial period of two years.

ASME Heat Transfer Division Symposium at Purdue

Banquet night. *Left to right:* Prof. C. F. Warner; Prof. S. P. Kezios; T. J. Dolan, Vice-Pres. of ASME's Region VI; Dean G. A. Hawkins; Speaker A. V. Astin; Guy Waddington; W. E. Hammond, Chairman of the Heat Transfer Division; D. E. Blue, Chairman, Central Indiana Section: *Far right:* Prof. Y. S. Touloukian.

Symposium on

Thermal Properties of Gases, Liquids, and Solids

Left to right: W. M. Steffen of Northrup; A. K. Doolittle of Union Carbide; J. F. Haskins of Convair Astronautics; J. F. Fernandez, Convair, Ft. Worth

C. W. Beckett, National Bureau of Standards, makes a plea for increased effort in heat-transfer research

THE Heat Transfer Division of The American Society of Mechanical Engineers held a special conference, Feb. 23–26, 1959, at Purdue University, Lafayette, Ind., a symposium on the thermal properties of gases, liquids, and solids.

The Division's Standing Committee on Thermophysical Properties, responsible for the technical part of the conference program, has held two previous symposiums. But this one represented a considerable enlargement in size and scope over the previous meetings, both of which were held as part of ASME Annual Meetings.

At any gathering of the Society's Heat Transfer Division, one senses a dynamic at work. In today's drive toward new goals in engineering—from new manufacturing processes to rockets and nuclear energy—the challenge is nowhere greater than in the field of heat transfer. The response to this challenge can be observed in the great number of technical papers produced by the Division, in the high attendance at its technical sessions, and in the Society's new publication, *Journal of Heat Transfer*.

A Special Symposium

The Society's Annual Meeting in December, 1958, could not contain all the technical papers prepared by the Heat Transfer Division. Result: The special symposium sponsored by the Division in co-operation with the ASME's Indiana Section and Purdue University's Thermophysical Properties Research Center. More than 200 engineers were guests of the University during the four days which saw the presentation and discussion of 42 technical papers.

The banquet, held on the evening of February 25, heard an address by Dr. A. V. Astin, Director of the National Bureau of Standards. His subject was, "How Critical Are Critical Tables."

This is by no means the first time that Purdue, which has produced a number of Presidents of the ASME, has been host to ASME gatherings. It is, however, the first time since the construction of the Memorial Center. Registrants at this conference walked the gleaming corridors of the new building, settled themselves in seats in the Fowler Auditorium, and listened to technical papers by leading engineers from the U. S., Switzerland, Great Britain, and Germany.

At the opening session, the morning of February 23, the conference was addressed by Prof. Y. S. Touloukian, the symposium's General Chairman, Purdue President Dr. F. L. Hovde who made a welcoming speech, D. E. Blue, Chairman of the Executive Committee of the ASME's Indiana Section, and Prof. S. P. Kezios of Illinois Institute of Technology, past-chairman of the Heat Transfer Division.

The Bound Volume

For the first time at a Heat Transfer Division conference, the technical papers were provided in book form, a cloth-bound volume of 472 pages. This book, jointly published by ASME and McGraw-Hill, is now available[1] through the Order Department of the ASME. The 42 papers appear in the order in which they were presented at the conference. The papers are divided into groups as they were at the symposium:

Theoretical Estimation of Transport Properties
Review of Recent Work on Transport Properties
Thermodynamic Properties: Gases and Liquids
PVT Data and Equation of State
Thermodynamic Properties of Boron Compounds
Transport Properties: Experimental (two sessions)

[1] "Thermodynamic and Transport Properties of Gases, Liquids, and Solids," containing all 42 of the technical papers presented at the symposium, may be ordered from the ASME Order Department, 29 West 39 Street, New York 18, N. Y. The price to members, $10. To nonmembers, $12.50.

University attracts an international audience

High-Temperature Transport Properties of Metals and Ceramics
High-Temperature Thermodynamic Properties of Gases

Professor Kezios, in a preface to the book, announces that consideration is being given to a plan to hold this forum more often than before, perhaps every two or three years. In another introductory statement, Professor Touloukian observes that, "The most serious bottleneck in present technological advance lies in the lack of knowledge of the properties of matter, of which the thermal properties constitute a major segment."

As the technical sessions progressed, the listener received the curious impression that science was beginning all over again. In a way, it is. The word "theory," occurring in the titles of so many of the papers—"Theories of Gas Transport Phenomena," "Review of Modern Theory of Thermal Conductivity of Metals"—gave a hint of the basic research in progress.

The Vanishing Lead Time

The truth is that the hardware has changed in revolutionary manner, while the replenishment of input information has been comparatively slow. The lead time between science and engineering is just about disappearing.

The fifth session offered an example of an area where engineering stands ready to use the new science as fast as it comes from the laboratories. The session took up the properties of boron compounds, components of the so-called exotic fuels.

From the standpoint of both speakers and audience, the university's Fowler Hall was superbly equipped, offering every comfort and convenience. An innovation was the "traffic light for speakers," a green-yellow-red light mounted on a stand near the chairmen's table and operated by the chairman. When the speaker had used all but two minutes of his alloted time, the light would be changed from green to yellow; two minutes later, to red. The traffic light may have had some small part in the smooth, on-time running of the technical sessions. More important, however, was the careful planning and preparation by chairmen and speakers.

The TPRC

The symposium's General Chairman, Y. S. Touloukian, is in his second round of chairmanship of the ASME's Standing Committee on Thermophysical Properties. (He was chairman a decade ago.) He is also Director of Purdue's two-year-old Thermophysical Properties Research Center. A feature of the conference was the opportunity to visit the offices of TPRC and observe its facilities. Up to now, TPRC's work has been in documentation, the development of a system of substance classification, and the storage and retrieval of information on thermophysical properties.

The need is great. Not only is there more research in certain areas, but there are also more areas. And the areas will continue to split up. More and more, the mechanized storage and retrieval of technical data—such as that being developed by the TPRC under Dr. Touloukian's direction—will be essential to engineering progress.

A buffet supper, on the first evening of the conference, proved more than ordinarily rewarding because of the tremendous range of interest of the attending engineers. Put a group at a table—an example: men from Lockheed, General Electric, Rensselaer, National Bureau of Standards, International Harvester—and these seasoned engineers question one another with the eager curiosity that undergraduates ought to exhibit but seldom do. Subjects range from the electrical characteristics of carbon at low temperature to the problems of the storage of helium.

Critical Tables

At the banquet, held on Wednesday, Dr. Astin defined critical tables as those produced by specialists in accordance with rigid specifications, "the most sophisticated of all scientific data." The tables receive the title "critical" for three reasons: The data tabulations are urgently needed for research and development; they are compiled and published only after being subjected to careful review; and the tables themselves are continuously and critically analyzed.

"Although information is pouring out from scientific laboratories in a veritable torrent which threatens to clog all channels of communication, essential data are not reaching those who need such information. In a time of information plenty, we are running the risk of starvation," said Dr. Astin.

To combat this danger, Dr. Astin explained, we have the Scientific Information Service, in the National Science Foundation, to further the effective dissemination of data. The foundation is providing important support to the work of the Office of Critical Tables of the National Research Council.

"This office," he said, "will provide the focus for authoritative data compilation work all over the country, and also will serve to co-ordinate such effort. . .

"(The tables). . .afford a most constructive means of permitting individual scientists to build upon the efforts of other scientists, and of enabling engineers to apply scientific knowledge to constructive ends. . . .We must add substantially and wisely to the present very modest effort, in order to develop these tools to a degree essential to the service of science, technology, and the national welfare."

Dr. Guy Waddington, Director of the Office of Critical Tables, National Academy of Sciences, National Research Council, served aa toastmaster.

Conducted for the National Junior Committee

A. S. GOLDSTEIN

JUNIOR FORUM

ASME Publications

By A. T. Wuska[2]

Many associate members of ASME are not fully aware of the vast storehouse of information and knowledge contained in ASME publications. In fact, many members are not even cognizant of the technical literature and services made available to members of the engineering profession. This article written for the associate member presents a brief description of available technical literature. Further inquiries on the subject are encouraged and welcome.

The task of producing and publishing periodicals, books, technical papers, and reference volumes has developed into big business, and today ASME is a major contributor to the technical publications world. The Publications Committee, under the Board on Technology, formulates policy and supervises the various technical publications of the Society.

ASME publications are available to individuals, industrial concerns, educational institutions, and libraries throughout the United States and abroad. Each periodical provides a comprehensive, permanent, and readily available source of vital technical information.

The ASME publication most familiar to the membership is MECHANICAL ENGINEERING. Every ASME member receives this monthly journal which contains outstanding technical papers, abstracts of current periodicals and events, engineering progress, engineering news of the world, extracts covering new equipment, and many other items of interest.

Effective January, 1959, the ASME Transactions will be published in a new series of five quarterlies: the *Journals of Basic Engineering*, *Engineering for Power*, *Engineering for Industry*, *Applied Mechanics*, and *Heat Transfer*. Each of these journals contains the highest quality permanent-interest reference papers which have been presented at the various technical meetings and conferences sponsored by ASME. Thus these journals provide for the engineer a quick and efficient method of expanding his knowledge in his particular field of endeavor.

Applied Mechanics Reviews, a monthly periodical, summarizes important developments, information, and events in the field of applied mechanics which are published in over 700 leading periodicals. This engineering review journal is outstanding in the publications field and has grown steadily with engineering progress. Each review bears the signature of the reviewer, thus attesting to the authority of the stated opinion.

A most valuable asset to the engineer's library is the Mechanical Catalog. In this yearly publication, leading manufacturers supply the latest technical information and specification data on their indexed products. Also included is a directory containing over 40,000 listings of various products and manufacturers.

A. T. Wuska

In accordance with the Society's basic aim of advancing the art and science of mechanical engineering, ASME has either sponsored or cosponsored many of the codes and standards in use in industry today. The most notable one, of course, is the ASME Boiler and Pressure Vessel Code. The various sections of this code outline safe rules for construction and maintenance of boilers and pressure vessels. These rules are a basis for the codes of our cities and states as well as military specifications.

ASME has been prominent in the field of standardization and has worked closely with the American Standards Association to achieve this end As would be expected, ASME has participated in many standards in the piping, threading, tool, power, and mechanical fields.

Everyone who has attended any of the conferences or technical meetings is familiar with the availability of Technical Paper Pamphlets. The society performs an outstanding service to scientists and engineers alike by preparing the pamphlets in advance of the meeting, in a useful and attractive format.

Many other special ASME publications and biographies are available to the scientists and engineers of the world. Among them may be found the Metals Engineering Handbook, Nuclear Engineering publication, the Materials Handling Handbook, and PPM—*Journal of Applied Mathematics and Mechanics*.

It is not the intent of this article to sell ASME periodicals to the membership but merely to advise availability. ASME is providing a valuable service to engineers and scientists in an effort to fulfill its mission of advancing engineering, industrial, and economic progress.

(The 1959 Listing of ASME publications, AM-3, is available from the Society upon request.—Editor)

[1] Engineering writer, G. E. Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

[2] Assistant superintendent, Inspection Department, American Cast Iron Pipe Company, Birmingham, Ala. Assoc. Mem. ASME. Junior Representative on ASME Publications Committee.

ASME CODES AND STANDARDS WORKSHOP

New Twist Drill Standard Approved

By Harry J. Moffatt, Chairman, B5 TC7

A NEW revision of American Standard Twist Drills has been approved by ASA and published by The American Society of Mechanical Engineers.

Combined drills and countersinks, 22 selected sizes of millimeter drills and screw machine length drills were added to the standard as requested by the user group.

In the past, some difficulty was caused by the misinterpretation of jobbers and short length drills. The short, medium, and long lengths are replaced by screw machine, jobbers, and taper length.

As this revision was in the final stages of completion, considerable comment was received in regards to a decimal marking system and also the elimination of overlapping sizes. The committee was in agreement that both of the requests should be considered but due to the length of time it would take to resolve such a proposal the revision should be completed and distributed for use during the interim. The American Society of Tool Engineers, through their Chapter Standards Committees, are making a survey throughout industry to determine the demand for a new marking system. The results of this survey will be used by the committee as a basis for a further study of this standard. The committee would appreciate any comments from industry as to how this standard can be improved upon to further its acceptance and use.

Copies of the standard are available from ASME Order Department, 29 West 39th Street, New York 18, N. Y.

New Standard on Taps Available

By W. J. Eberlein, Chairman, BC TC12

THIS publication includes the many changes in practice which have taken place since the 1948 issue of B5.4. A most important development was the Declaration of Accord with respect to the Unification of Screw Threads which was signed in November, 1948, by representatives of the American, British, and Canadian governments and industry bodies, including the American Standards Association, The American Society of Mechanical Engineers, and the Society of Automotive Engineers.

The unification provided for interchangeability between American and British screw thread systems and created Unified classes of thread tolerances which have been widely adopted by American industry.

The Unified tolerances permit the use of taps made to higher limits, which led to a revision of tap tolerances now designated as "High" for ground-thread taps made to tolerances over basic, and "Low" for ground-thread taps made to tolerances under basic, and identified by the letters "H" and "L," respectively. Pitch diameter tolerances of the new H and L ground thread taps were established at 0.0005 in. in sizes under 1 in., whereas formerly a tolerance of 0.001 in. was in most general use. Tap standards now provide a wider selection of ground-thread taps to secure classes of thread tolerance desired with maximum wear life.

Included in the text are descriptions of various tap styles and a greatly expanded section on nomenclature and definitions. There are 20 tables of complete specifications of standard taps, including new styles of taps such as oversize machine screw taps, helical flute taps, and spiral point taps with short flute, which have been introduced as standards in recent years. Also included are tables listing tap recommendations for all classes of Unified and American Screw threads.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held at Arden House, Harriman, N. Y., on Friday, Feb. 6, 1959. There were present: G. B. Warren, chairman; E. W. Allardt, L. N. Rowley, and R. B. Smith of the Executive Committee; H. S. Aurand, C. H. Coogan, Jr., T. J. Dolan, Harold Grasse, G. R. Hahn, and J. W. Little, Vice-Presidents; V. W. Smith, a director; E. J. Kates, treasurer; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; W. E. Letroadec, W. E. Reaser, and S. A. Tucker, assistant secretaries; J. J. Jaklitsch, Jr., editor; H. I. Nagorsky, controller; and D. B. MacDougall, associate head, Field Service.

The following actions of the Council are of general interest.

Dues of Members in Foreign Countries. The policy regarding dues of members in foreign countries was adopted and the special committee which made the study was discharged with expressions of appreciation of the Council.

Boiler and Pressure Vessel Committee. The Council authorized the payment of $1000 to the American Welding Council of the Engineering Foundation as the 1959 contribution of the Society to the work of the Pressure Vessel Research Committee.

Sections. Upon the recommendation of Vice-President Coogan, Region I, the Council approved the formation of the Vermont Group of the Northern New England Section subject to the payment, prior to July 1, 1959, of dues by any petitioners who are now in arrears and the designation of a headquarters city. The group shall consist of the following

counties of Vermont: Franklin, Orleans; Lamoille, Crittenden, Addison, Rutland, Essex, Caledonia, Washington, and Orange.

ASME-ARS Agreement. The Council voted to grant to members of the American Rocket Society the privilege of purchasing at members' discounts those publications of ASME which are sold to ASME members at a discount provided a reciprocal agreement is adopted by ARS; this arrangement to be in effect until Dec. 31, 1960, at which time it may be renewed by mutual agreement.

ASME Insignia. The Council authorized the use of the ASME Clover Leaf in the March, 1959, issue of *The Tool Engineer*, published by the American Society of Tool Engineers, for the purpose of illustrating an article on the joint ASTE-ASME technical session to be held April 21, 1959.

Charles F. Kettering. In accordance with the action taken by the Council at the 1958 Annual Meeting, the resolution prepared for Charles F. Kettering was noted.

Certificates of Award. Upon recommendation of past vice-presidents, W. H. Byrne, Region II, and J. H. Sams, Region IV, Certificates of Award have been granted to the following: F. L. Bradley, Sections Chairman, Region II; William Welch, Jr., Student Sections Chairman, Region II; H. H. Johnson, Membership Development Chairman, Region II; W. H. Larkin, Civic Affairs Chairman, Region II; A. T. Kniffen, Regional Secretary, Region II; and K. R. Daniels, Membership Development Chairman, Region IV, 1956–1958.

Upon recommendation of past vice-president, W. H. Byrne, Certificates of Award were granted the following: A. R. Mumford, 1955–1956, and R. W. Flynn, 1956–1957, Sections Committee; H. R. Kessler, 1955–1956, Student Sections Committee; V. W. Smith, 1955–1956, and A. M. Perrin, 1956–1957, Membership Development Committee; H. C. R. Carlson, 1955–1956, Civic Affairs Committee; V. W. Smith, 1956–1957, Advisory Planning Committee; and W. L. Betts, 1954–1956, Regional Secretary.

Certificates of Award have been granted to the following 1957–1958 retiring Section Chairmen: D. C. Smith, Kansas City; and E. C. Miller, Worcester.

The following retired committee chairmen were granted Certificates of Award: John Gammell, 1957, Education Committee; H. N. Meixner, 1954, Education Committee; R. C. Allen, 1954–1955, Research Executive Committee; and T. H. Wickenden, 1956, Research Executive Committee.

Members of committees who were granted Certificates of Award include: Walter Samans, Boiler and Pressure Vessell Committee; and D. S. Bell, 1949–1958, T. H. Wickenden, 1946–1948, and Taylor Lyman, 1946–1958, all of the Metals Engineering Handbook Committee.

A Certificate of Award was granted to D. G. Reid for outstanding development of Codes and Standards formulated under ASME sponsorship.

Royal Belgium Society of Engineers and Industrialists. The Council noted with deep regret the death of Robert Van Cauwenberghe, president, the Royal Belgium Society of Engineers and Industrialists, on Dec. 14, 1958.

The Executive Committee of the Council reconvened on Sunday, Feb. 8, 1959, at Arden House, Harriman, N. Y. There were present: G. B. Warren, Chairman; E. W. Allardt, R. B. Smith, and A. W. Weber of the Executive Committee; H. S. Aurand, C. H. Coogan, Jr., T. J. Dolan, Harold Grasse, G. R. Hahn, and J. W. Little, vice-presidents; V. W. Smith, a director; O. B. Schier, II, secretary, T. A. Marshall, Jr., senior assistant secretary; W. E. Letroadec and W. E. Reaser, assistant secretaries; J. J. Jaklitsch, Jr., editor; and D. B. MacDougall, associate head, Field Service.

United Engineering Center. The Council authorized the eight Vice-Presidents to contact Section Member Gifts Chairmen by telephone or in person so as to effect an early completion of the ASME Member Gifts Campaign; and authorized expending up to $5000 from a special UEC fund to defray telephone and travel expenses incurred by them.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	57 Post St

Men Available[1]

Mechanical Engineer, BSME; 26, single; five years in manufacturing, oil-field operation, design, equipment specifications, and corporation budget in farm machinery and oil industries. Languages: English, Spanish, French, Italian, and Portuguese. Desires project work or technical representation for company having overseas operations. Me-696.

Project Engineer, BME, MSME.; PE; 29; four years design and development gas and diesel engine-driven electrical machinery. Familiar with machine-shop procedures, sheet-metal fabrication, and electrical machinery manufacturing methods. Prefers East. Me-697.

Industrial or Sales Engineer, BSME; 34; eight years' experience, methods, plant layout, sales, production, and general administrative work. Presently employed with electronic industry, seeks position in growing and dynamic organization. Prefers northern N. J. or metropolitan New York. Me-698.

Recent Graduate Mechanical Engineer, 27; interested in steam power, air conditioning, service, processing, or manufacturing engineering. Summer experience with steam turbines and air conditioning. Will relocate or travel. Me-699-933-Chicago.

Engineer, Manager, BSME; 47; 24 years' experience; industrial-management engineering, plant engineering, product design, development. Organized, managed, complete operations; job shop, line, and process; in metal working, machinery building, grinding-wheel manufacture. Prefers Midwest or East. Me-700.

Plant Engineer or Plant Manager, BME; 39; 17 years' diversified experience in plant layout, piping, quality control, and maintenance planning and supervision in chemical, power generation, and railroad industries. Seeks responsible position in chemical or pharmaceutical plant. Prefers N. J. Me-701.

Director Product Development, Director Engineering and Research, Chief Engineer, BSME and BS Aero. Engineering; 55; 25 years' experience in design and administration—research and development, engineering, labs, experimental models, patents and procedures, field testing, customer relations, automation and production processing methods, and special products. Prefers Midwest, South. Me-702-935-Chicago.

Director of Research and Development, BME, BEE, PE; 41; five years' electrical-mechanical

[1] All men listed hold some form of ASME membership.

development, 13 years' steel-mill plant-engineering supervision, three years' nuclear engineering management. Heavy experience machine design, operation and maintenance. Cost control, proposals, and customer relations. Nuclear research facility design and construction. Me-703.

Mechanical Engineer, PhD, ME; 30; one year industrial experience, two years' military engineering development, one and one half year assistant professor, mechanical engineering at both graduate and undergraduate levels; desires position in industry doing research in heat transfer. Prefers New York Metropolitan Area. Me-704.

Mechanical Engineer, BS and MS(ME); '35; two years' linear acceleration component design and heat transfer; three years' air conditioning, refrigeration, and heating for architect engineer; one year aircraft air conditioning; two years' air-conditioning and refrigeration installation supervision. Prefers Calif. Me-1111-San Francisco.

Positions Available

Product Manager, Machinery Sales Department, mechanical or chemical graduate, seven to ten years' experience, including field sales. Must be familiar with chemical processing and machinery or equipment used in unit operations; direct sales, marketing, or promotion experience. Major responsibility will be in sales and sales development in new markets of established machinery item and new product. Duties will include sales promotion, market development, pricing, field stimulation, engineering co-ordination on new or established machinery products. Salary commensurate with qualifications. Upstate N. Y. W-7054.

Chief Acoustical Engineer, graduate mechanical, practical experience in research and development involving noise-suppression devices and their applications. Previous administration of a department and knowledge and experience in project handling and manufacturing methods. Will be in charge of all silencer-engineering research and development programs involving metal noise-suppression devices. Will evaluate progress and results and recommend major changes in procedures and objectives. $14,000. New England. W-7057.

Service Engineer, Plastic-Forming Machines, previous experience as machine operator, mechanic, or serviceman on plastic vacuum-forming equipment required. Primary duty will be to service plastic vacuum-forming machinery in the field. Will work closely with customers in assuring their plastic-forming machinery is functioning properly. Some installation work required. Must be willing to travel for short periods. $6500–$7500. New England. W-7058.

Process Engineer, graduate mechanical, practical experience in manufacturing as a process engineer, particularly on welding. Knowledge of welding codes. Will study, investigate, and recommend improvements to existing welding methods and procedures. Review manufacturing operations related to use of sheet metal in order to reduce cost and improve efficiency; recommend changes in design and construction when required. $8000–$9500. New England. W-7059.

Machine Designer, graduate mechanical, minimum of five years' board experience. Work will be on design of special machines and tooling used in forming operations on light gage metal. Must be able to carry through on assigned projects in translating new ideas into workable equipment; should have strong interest in practical manufacturing problems. $7000–$9000. Conn. W-7064.

Industrial-Engineering Manager, graduate industrial or mechanical engineer, preferably with some previous supervisory experience in industrial engineering. Duties will involve the continuation and development of a progressive plant industrial-engineering program, including investigation of equipment utilization, manning, instrumentation, and automation in a chemical-mechanical operation. Five to ten years' experience involving investigations culminating in full-recommendations concerning methods and production studies, departmental operations, material handling, etc. $8400–$9600. Conn. W-7093.

Methods or Processing Engineer, engineering degree preferred but not essential. Must have at least two years' time study, two years' tool design, two or more years' methodizing and process writing. Ability to handle a complete product project from prints to final assembly for efficient low-cost manufacture. $8000. Conn. W-7094.

Chief Engineer, considerable experience in the

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE (e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.) | NATURE OF WORK DONE

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

Address changes effective when received prior to:

I subscribe to

☐ MECHANICAL ENGINEERING	10th of preceding month
☐ *Journal of Engineering for Power*	20th of preceding month
☐ *Journal of Engineering for Industry*	
☐ *Journal of Heat Transfer*	
☐ *Journal of Basic Engineering*	
☐ *Journal of Applied Mechanics*	
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
☐ I—Human Factors Group	☐ R—Railroad	

design and application of pumps, particularly as used by the petrochemical industries. Small company; heavy emphasis on engineering and quality. $15,000. Midwest. W-7099.

Assistant to Product-Planning Manager, electrical or mechanical graduate, some courses in design, accounting, economics, and production control. Will consider recent graduate mechanical or electrical with additional courses in accounting or business administration. Experience as project engineer or project coordinator of new product development highly desirable, also data processing, sales engineering, or accounting. $7000–$10,000. Relocation expenses and placement fee paid by company. Conn. W-7100.

Project Engineer, graduate mechanical or electrical, experience in development and production engineering of electronic and electromechanical avionic devices, for company which manufactures and designs controls, timers, intervalometers, armament, and ECM controls. About $11,000. New York, N. Y. W-7101.

Design Engineer, graduate mechanical or electrical, three to five years' experience in hydraulic or precision instrumentation, design, and development, preferably in missiles or aircraft systems. $10,000–$12,000. Upstate N. Y. W-7106.

Engineers. (*a*) Plant manager, manufacturing, graduate industrial or mechanical engineer, ten years' experience in machine tools essential. Will have responsibility for the operation of a manufacturing division. Must be thoroughly familiar with all machine tools, assembly operations, and modern manufacturing practices. $9680–$13,800. (*b*) Industrial-engineering supervisor, graduate industrial engineer, six to eight years of machine-tool background necessary. Should know and understand methods and processes for large and small machining operations. Should have a minimum of four to five years' experience in time-study work. $7200–$9000. Midwest. W-7107.

Plant-Maintenance Engineer, mechanical or electrical graduate, preferably with PE license, to supervise installation, operation, and maintenance of air-conditioning and power equipment. Must be citizen. $12,000–$15,000. Chicago area and eastern seaboard. W-7110.

Process Engineers, engineering degrees or equivalent in mechanical, electrical, or chemical engineering. (*a*) One with a minimum of six years' experience in production engineering, designing, and installing manufacturing equipment. Gadgetering, processing, trouble shooting, getting new products into production, plant engineering, cost-reduction projects. To $9000. Central U. S. (*b*) One with a minimum of six years' experience in metal manufacturing, tool design, knowledge of tools, cost-reduction projects. To $9000. Northeastern U. S. (*c*) One with a minimum of six years' experience, preferably in lime. Lime engineer preferred. To $9000. Northeastern U. S. W-7113.

Plant Superintendent, manufacturing experience; considerable experience handling foremen and labor and dealing with labor problems. Should be aggressive and capable, with an appreciation of cost control. Problem-solving type of man desired. To $9000. Central U. S. W-7114.

Industrial Engineers, Junior and Senior, two to ten years' experience in all or some industrial-engineering phases of the needlework or sewing-products trade, for firm of industrial-management consultants. Positions open for European assignments as well as domestic. $6000–$20,000. W-7128.

Sales-Application Engineers, three to five years out of college. (*a*) Mechanical, machine-tool, and shop background for sale of special cutting tools. (*b*) Mechanical or metallurgist for sale of extreme high-temperature refractories as used in aluminum, steel manufacture. $7500–$8000. Northern N. Y. State. W-7129.

Professors for Foreign Assignment in Middle East, (*a*) Professor, business administration. (*b*) Professor, engineering (mechanics, heat transfer, fluid mechanics). (*c*) Professor of physics. $6000–$7000, nine months. Positions available September, 1959. F-7130.

Engineers for a company which is predominately a heavy forge and machining industry. (*a*) Senior die designer, mechanical graduate, to design dies and co-ordinate the die-design activities as related to product processing, sales inquiries, and die-cost estimating and customer contacts. Must be familiar with closed and open die-design activity. (*b*) Mechanical engineer, graduate, to design air-conditioning systems, ventilating systems, exhaust systems, steam generation, heating systems, process and service piping, pneumatic and hydraulic systems, process water treating, melt and forging furnaces, and general plant mechanical equipment. Pa. W-7138.

Mechanical-Development Engineer, experience in machine design and/or electrical control circuits as applied to manufacturing equipment. Textile or allied machine experience preferred. Salary open. Va. W-7146.

Mechanical Engineers. (*a*) Mechanical design engineers, graduates, experience in the design of precision machinery. Knowledge of gear boxes, couplings, drives, weldments, castings, and other components used in radar pedestals and other special rotating machinery. Positions open at various levels of experience. (*b*) Mechanical checker, at least ten years' experience in machinery design and checking. Familiarity with engineering and drafting standards and government specifications. Thorough grounding in shop and drafting practices, realistic tolerances and in principles of design for economical manufacture. Work involves weldments, castings, gear boxes, slip rings, bearings, housings, etc. (*c*) Design-draftsman, experience on special machinery, weldments, castings, bearings, housings, seals, etc. Knowledge of shop practices, materials, tolerances, and government specifications. Must be U. S. citizens. Suburban northern N. J. W-7157.

Production Engineer, two years of college or equivalent, five to ten years' experience, to plan manufacturing processes, tooling, equipment, methods, procedures, and techniques for fabrication and assembly of electromechanical products. This includes cost estimating, time study, operation-sheet writing, trouble shooting, and improving present manufacturing processes, but primarily concerned with production engineering of new products to factory. Familiarity with various electrical and environmental production-test setups preferred. $7000. N. J. W-7159.

Senior Mechanical Engineer, MS or better, minimum of ten years' experience, to carry out high-level engineering work, comprising both analysis and creative engineering. Major field in "hardware" requiring a knowledge of stress analysis, dynamics, hydraulics, structural analysis, heat transfer. Good analytical ability important. $11,500. Company will pay placement fee. Conn. W-7160.

Engineers. (*a*) Reliability engineer, BSME, seven years' experience, to prepare, review, and analyze reliability specifications for mechanical and hydraulics, to assure that reliability requirements of hardware groups are met. Assist test group in design of test equipment so as to meet reliability requirements. $8060–$9880. (*b*) Test engineer, BSME or BME, six to seven years' experience in mechanical engineering and design of missile handling, launching, and support equipment, including three to five years' experience in hydraulic components. Will prepare test-components plans and schedules, including test specifications for mechanical and hydraulic devices. $8840. (*c*) Hydraulic engineer, BSME; minimum of seven years' engineering experience, five years in power and control hydraulics. Will assume project responsibility involving component design and schematic representations. Complete follow-through on design, detail, and manufacturing liaison of ground handling and launching equipment. $8840–$9880. (*d*) Technical editor, BA or BS, three years' minimum experience in report and proposal editing and production as well as preparation of technical handbooks and brochures. Final preparation of engineering reports, proposals, and brochures. Thorough knowledge of reproduction methods, page layout, interpretation of test and illustrative material, etc. $5720–$7020. Company will pay placement fees. Conn. W-7161.

Engineers. (*a*) Quality-control engineer, graduate mechanical, summer industrial experience desired but not necessary. Will assist in planning and expediting of statistical studies involving data collection and evaluation to determine standards, acceptance quality levels, and machine capabilities, etc. Should have an analytical and inquiring mind, be able to solve practical problems. $5500–$6000. (*b*) Sales engineer, trainee, preferably an engineering degree. After training period of about one year, will handle outside customer sales of instrument bearings. Must be willing to relocate. $5000–$6000 to start, with commission added after six months of selling. New England. W-7165.

Mechanical Engineer, ten years' experience; familiar with metal-working equipment; such as small rolling mills, slitters, chemical-process equipment; boilers and steam distribution and dust control. Will supervise development of a preventive maintenance program and assume project-engineering responsibilities. To $9000. Western Pa. W-7167.

Design Engineers. (*a*) Mechanical engineer, industrial process piping and piping-control instrumentation experience; some experience in hydraulics helpful. To $10,000. (*b*) One for design and development of electrodynamic vibration exciters, which are basically loudspeakers designed to vibrate or fatigue-test components or assemblies of rockets and missiles in development and production stages. Knowledge of dynamics and electromagnetics desirable. (*c*) One for design and development of electrohydraulic actuators operating at frequencies to 2000 CPS. Analytical background in dynamics, servomechanisms, and hydraulics required. (*d*) One for design and development of large power amplifiers and controls for electrodynamic vibration exciters over a frequency range of 5 to 5000 CPS. Design or production-engineering experience on 25 kw to 100 kw amplifiers desirable. Salaries on b, c, d, open. Excellent company benefits, including profit sharing. Conn. W-7169.

Plant Engineers, Design and Construction, graduate engineers in mechanical or chemical engineering, five to ten years' experience in plant design and construction. Experience must be in the chemical or oil industry. Duties will involve design and construction of multimillion dollar projects on new plants and expansion of present facilities. $9000–$12,000. Louisville, Baltimore, Chicago, and Cleveland. W-7172.

Eastern Editor, National Trade Publication, graduate mechanical or electrical, three to five years' experience in electrical-manufacturing or public-utility work and who likes editorial or report writing. $10,000. New York, N. Y. W-7175.

Sales Engineer, Junior, graduate mechanical. Company will train, but should have several years' experience with centrifugal-pump work or steam-power-plant equipment. $7200–$7800. New York, N. Y. W-7176.

Production Engineer, design and production experience on tools, fixtures, and dies, for manufacturer of optical frames. $8500–$12,000. New England. W-7177.

Industrial Engineer, graduate mechanical or industrial engineer, to organize and administer an incentive-standard-wage plan in a large foundry and machine plant in the nonferrous metal field. Salary open. Mass. W-7189.

Mechanical Construction Engineer, graduate mechanical, PE license. Requires extensive background in estimating, supervision, and erection of chemical refinery, process, and general piping projects. Should be familiar with construction practices, labor relations, and cost analysis of mechanical-erection contracts. Must have enough practical experience to direct both office and field personnel working on mechanical erection contracts. Will co-ordinate industrial contract division of a well-established mechanical contractor specializing in heating, refrigeration, air conditioning, process and power piping. Salary open; pension, insurance, and profit-sharing plans available. Company will pay placement fee and moving expenses to Chicago. C-7297.

Design and Development Engineer, graduate mechanical; some previous experience in 2-cycle gasoline engines. To start, will work in design and research department, on further development of portable, gasoline-powered and electric-powered tools. Should have personality and ability to advance to assistant engineering manager. Supervisory for a manufacturer of power tools. To $10,000. Wis. C-7309.

Assistant or Associate Professor, Machine Design, experience and MS preferred; qualified to develop and teach sequence of machine-design courses in newly established mechanical-engineering department. $6500–$7500 for nine months. West. S-4004.

Senior Process Engineer, mechanical graduate, five to ten years' experience in machine-shop production; to plan and schedule methods and procedures. $7800, and up. San Francisco Peninsula. S-4114.

Welding Engineer, Fabrication Shop or Piping Mill, graduate, extensive experience in plant-fabrication shop or pipe mills relative to examination and evaluation of welding capabilities and methods; able to examine potential suppliers at the site; determine their capabilities for contract purposes or evaluate and make recommendations for improvement in production of subcontract on plants. Salary substantial. Headquarters, London, England; work in Europe. S-4132.

Quality-Control Engineer, Welding, preferably BS in physics or metallurgy, with some practical experience in production welding of stainless steel, to set up standards and procedures for specification welding and be responsible for inspection in shop. Must be able to work with craftsmen. About $6600. San Francisco East Bay. S-4137.

Sales Engineer, Gas Meters, mechanical training, some industrial or selling experience and definite interest in sales work, for sales, service, and application engineering of complete line of gas-measuring instruments. Factory training in East—six months required. About $5400. San Francisco Bay Area. S-4138.

Senior Designer, Conveyers, graduate mechanical or equivalent, several years' experience preparing design drawings and specifications and handling small contracts. Must have good knowledge of mechanics of materials-handling machinery and equipment. To prepare detailed drawings and layouts of machinery, machine parts, and steel work involving original design and calculations according to customers' requirements, specifications for shop fabrication, estimating, handle orders to fulfill contracts. To $7600. San Francisco. S-4144.

Junior Engineers, manufacturing plant, electrical or mechanical, married and congenial for small, isolated community, to be trained for supervisor or executive position with large national manufacturer of building materials. $5600 a year if without experience, or better if experience warrants. Southern Calif. S-4150.

Junior Designer, Conveyers, graduate mechanical, capable of using drafting equipment. Under direct supervision, prepare detail drawings and layouts for machinery parts and steelwork, specifications for shops and estimating department, calculations. To $6300. Employer will pay placement fee. San Francisco. S-4164.

Mechanical Designer, Office Machinery, prefer graduate mechanical, two to six years' experience, for layout, design, and detailing of small mechanisms on business machines. About $7200 to start. Permanent. San Francisco East Bay. S-4172.

Field Layout Engineer, Process Plant, graduate, experienced in and familiar with construction procedures, taking off quantities, ordering materials, cost analysis, field layout of pipe and process-plant facilities from flow sheets. For construction company. Temporary, possibly permanent. $8400–$9600. Sacramento, Calif., area. S-4182.

Industrial Engineer, plumbing ware, industrial engineer, or equivalent; should be experienced in and have potential for supervisory work in time study, incentives (piecework), the development of production standards, methods improvement, work simplification, relating to material flow in continuous process of slurry casting porcelains for manufacturing plant of about 200. About $7200. San Francisco Bay Area. S-4183.

Design Engineer, mechanical or electrical graduate, some design-board experience on H&V and plumbing. Desirable to have some electrical design experience or willing to learn; also wiring and controls. Salary open. San Francisco. S-4186.

Professor, Mechanical Engineering, PhD; teaching and industrial experience desirable; to head rapidly growing department in expanding industrial area. Specialty in thermodynamics desirable. $8000–$9500 for nine-month year. West. S-4187.

Designers, Recording Instruments, BSME or EE. (*a*) Mechanical engineer, experience designing and laying out work for assistants in small, precision-instrument field. $7200–$9000. (*b*) Mechanical engineer, two or three years' experience on design and development of electromechanical instruments. $6600–$8400. Prefer U. S. citizens. San Francisco Peninsula. S-4189.

Project Planning Engineer, Building Materials Process, chemical, mechanical, mining, or electrical, three to ten years' experience in work relating to central engineering-department planning for multiplant operations for a manufacturer of building materials, roofing, paper board or paper products; should be capable of handling planning, layouts, specifications for plant construction, expansion, modifications for increased production, improvement at pilot or operational stages; must have potential to develop into project man superintendent, or plant engineer. $7200–$8400. San Francisco East Bay. S-4191.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after April 24, 1959, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

Alabama

BOTTOMLEY, GODFREY S., Birmingham
SHAW, WINFRED A., Auburn

Arkansas

GRANT, WILLIAM H., Little Rock
LEMKE, RAYMOND, Little Rock

California

ANDERSON, GORDON M., Santa Rosa
CARRIER, JOSEPH A., Manhattan Beach
CRAWFORD, FRANKLIN G., Los Angeles
GROSS, JOSEPH F., Santa Monica
GUNTHER, GREGORY M., Los Angeles
HALPENNY, WILLIAM H., Los Angeles
MASSEY, RICHARD W., Anaheim
MERIAM, JAMES L., Berkeley
•NORTON, DONALD L., Arcadia
POTTER, HAROLD L., Torrance
VALSTAR, JACOB E., Los Angeles
WILHOIT, JOHN W., San Francisco

Colorado

LUBECK, CHARLES M., Englewood

Connecticut

ACKERMAN, NORMAN, West Hartford
BLAKE, ALEXANDER, Bristol
BERNATOWICZ, BRZOZOWSKI F., Waterbury
CANNING, GORDON, JR., Weston
CASSIDY, LEO M., Groton
CEPLUCH, ROBERT J., Wethersfield
HALL, RAYMOND S., JR., New London
HARLAND, RAYMOND F., Milldale
HOOPER, ROBERT W., West Haven
HORTON, ULRIC G., West Hartford
IVES, FREDERICK D., Hartford
MCKENNA, JAMES E., Waterbury

Delaware

BRILL, WALTER R., JR., Wilmington
•BRYANT, ROBERT E., Wilmington
DELAPLANE, RALPH E., JR., Newark
IANNI, RAYMOND E., Wilmington

District of Columbia

FAROOQI, MOHAMMED R., Washington

Florida

COLDEWEY, TOM S., Port St. Joe
GROOM, JIMMY W., Pensacola

Georgia

FLING, THOMAS A., Atlanta

Illinois

DELMASTRO, FRED T., Villa Park
DODDS, RODERICK P., Chicago
•DUNNING, ERNEST L., Carbondale
HAMILTON, THOMAS B., Arlington Heights
KARG, KENNETH C., Chicago
JENRATH, HUGO A., Elmhurst
•JONELIS, ROBERT E., Lombard
•SCHEIBEL, ROBERT F., Arlington Heights

Indiana

HOUGHTON, ARTHUR V., 3RD, West Lafayette

Iowa

JACOBSON, WAYNE D., Cedar Rapids

Kentucky

MILES, GEORGE P., Shreveport
SANTOS, RONALD R., Harvey

Maryland

•MULLEN, WILLIAM A., Baltimore
RYKOSKEY, FRANCIS B., Baltimore
STANLEY, WILLIAM W., Pasadena
•WOOMERT, DALE E., Aberdeen

Massachusetts

BIDWELL, PAUL W., Holyoke
CHU, CHAUNCEY C., Dedham
•GILLIS, JOHN R., Lexington
ZEH, WALTER, Wilmington

Michigan

HERKOMMER, KARL H., Dearborn
LIV, LUN K., Detroit
PETERSON, WILLIAM A., Detroit

Minnesota

BERKMAN, JOHN W., Oronoco
KUNZE, JACK E., Rochester
•SWANSON, ALVIN E., Minneapolis

Mississippi

DUDDING, BEN A., JR., Cleveland

Missouri

BARTLEY, WILLIAM E., JR., Richmond Heights
MOTZ, PAUL, Kansas City

New Jersey

ALLISON, ROBERT P., JR., Upper Montclair
BARTLETT, JOHN L., Roselle
DOLLING, JENS C., Maplewood
MCPARTLAND, FRANCIS X., Englewood
MCINAR, JOHN, Moorestown
PERCARPIE, LOUIS F., Paterson
•STALKER, WILLIAM R., Bound Brook
SWYT, JOSEPH, Plainfield

New Mexico

RAY, KENNETH L., Santa Fe

New York

ALTAMURO, VINCENT M., New York
•BERMAN, IRWIN, New York
•BURDICK, JOHN S., New York
DAVIES, DOUGLAS W., New York
FLATOW, PAUL L., University Heights
GARNET, HYMAN R., Bethpage
GASKILL, WARD H., JR., Lockport
KELEDI, FRANK C., Rego Park
MOSHER, LESTER W., Endicott
PHILLIP, JOHN, New York
RAWS, WILLIAM W., Long Island City
SALTZGABER, RICHARD H., Rochester
•SELTZER, DAVID, New York
VOHTZ, ERIK, Schenectady
WESTWOOD-BOOTH, IAN J., New York

North Carolina

DAVIES, FREDERICK A., High Point

Ohio

COLEMAN, FRANCIS S., Shelby
DEITSCH, WILLIAM F., Cincinnati
DURIPANDIAN, N., Youngstown
•LYDECKER, LEIGH K., JR., Akron
•MCCRORY, ROLLIN J., Columbus
MCSHANE, JOHN FRANCIS, Mt. Vernon
MEHRBRODT, AL W., Cleveland
MIRTO, LAWRENCE, Youngstown
NIGAM, SHAMJI M. L., Youngstown
PITMAN, DONALD L., Newark
•WAGNER, WILLIAM A., Hannibal
WYLIE, ROBERT D., Barberton

Oklahoma

MYER, GLENN P., Pryor

Pennsylvania

BERLEY, LARRY, Media
BURLEIN, LESTER F., Honesdale
EICHELBERGER, THOMAS W., Pittsburgh
FINN, WILLIAM D., Pittsburgh
MORCH, CHARLES W., JR., Philadelphia
NOCITRA, SAMUEL J., Philadelphia
OLSON, PAUL E., Pittsburgh
•WARNER, PAUL C., Philadelphia
WRIGLE, ROBERT E., York
•YOUNGBLOOD, CHARLES E., Johnstown
ZIGA, ERNEST J., Pittsburgh

Rhode Island

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OBITUARIES

Dwight Phillips Bailey (1905–1958), assistant sales manager, Tidewater Oil Co., New York, N. Y., died Aug. 26, 1958. Born, Dansville, N. Y., Sept. 27, 1905. Education, BCh(CHE), Cornell University, 1927. Mem. ASME, 1949. Mr. Bailey had been with Tidewater since 1930. He was a member also of SAE.

George Lant Baker (1903–1958?), master mechanic, Maintenance and Repair Div., Ewa Plantation Co., Ewa, Oahu, T. H., died recently according to a report received by the Society. Born, Payson, Utah, April 28, 1903. Education, studied at University of Utah, 1920–1923. Mem. ASME, 1953. Mr. Baker had been secretary of the ASME Hawaii Section.

Burton Brower (1924–1958?), whose death recently was reported to the Society, had been with the Dwight-Transportometer Div., McDowell Co., Inc., Cleveland, Ohio. Born, Cleveland, Ohio, July 21, 1924. Education, BS(ME), Rutgers University, 1948. Assoc. Mem. ASME, 1952.

Robert Baker Donworth (1897–1958?), vice-president, engineering and construction, Duquesne Light Co., Pittsburgh, Pa., died recently according to a report received by the Society. Born, Seattle, Wash., May 14, 1897. Education, BA, Yale College, 1919; BS(E Ad.), Massachusetts Institute of Technology, 1921. Mem. ASME, 1946. Mr. Donworth was an author of the paper, "Description of the Pressurized Water Reaction (PWR) Plant at Shippingport, Pa." The paper earned its authors the 1956 Prime Movers Committee Award.

John Dennett Eberhardt (1894–1958), management consultant, Arlington, Mass., died Aug. 16, 1958. Born, Arlington, Mass., June 7, 1894. Parents, Philip E. and Nora M. (Dennett) Eberhardt. Education, BS, Massachusetts Institute of Technology, 1916. Mem. ASME, 1926. Mr. Eberhardt's chief interests had been in the wood industries. He had been a member also of the Society for the Advancement of Management.

Chester Hacking (1885–1959), consultant, William H. Haskell Mfg. Co., Pawtucket, R. I., died Jan. 8, 1959. Born, Pawtucket, R. I., Sept. 3, 1885. Education, Pawtucket Public Schools. Mem. ASME, 1928. He joined the Haskell firm in 1918 and in 1922 was advanced to superintendent in complete charge of the factory.

Charles Austin Hirschberg (1881–1958), owner, Streme-Liner Mfg. Co., Dover, N. J., died Aug. 13, 1958. Born, Syracuse, N. Y., Nov. 29, 1881. Parents, August and Gertrude (Austin) Hirschberg. Married Jeannette Valeria Norton, 1904. Affiliate ASME, 1917. Mr. Hirschberg held patents for several types of drilling apparatus. Early in his career he was associate editor and business manager for *Compressed Air Magazine*. He had published a number of articles, was the author of a book, "Compressed Air for Metal Workers," and was coeditor of the compressed-air section of "Kent's Mechanical Engineers Handbook," tenth edition.

Carl Roy Houghton (1879–1958?), whose death recently was reported to the Society, had been a consulting engineer, Connersville, Ind. Born, Bloomington, Ind., Oct. 1, 1879. Parents, W. R. and Alice (Neeley) Houghton. Education, BS(ME), Purdue University, 1904. Married 2nd, Rema Risk, 1927. Mem. ASME, 1920. Before entering consulting practice, Mr. Houghton had been with The Connersville Blower Co. from 1907–1935. He held numerous patents for valves, separators, pumps, meters, and the like.

John Henry Klinck (1872–1959), retired, Tampa, Fla., died Jan. 1, 1959. Born, Charleston, S. C., Sept. 13, 1872. Education, ME, Cornell University, 1894; MS, Lehigh University, 1899. Mr. Klinck had been with Westinghouse Electric & Mfg. Co. Mem. ASME, 1904.

Charles Harold Leach (1895–1958), manager, Engineering Equipment, Ltd., Englewood, N. J., died February, 1958. Born, Smiths Falls, Ont., Canada, Oct. 17, 1895. Education, ICS. Mem. ASME, 1944. Mr. Leach had been a specialist in the design of heat-exchanger apparatus and processes for oil refining.

Guerard Mackey (1908–1958), civil engineer, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., and chairman, ASME Maintenance and Plant Engineering Division, died Dec. 4, 1958. Born, Chicago, Ill., July 28, 1908. Parents, William P. and Emily F. Mackey. Education, BS(ME), University of Illinois, 1930; graduate study at Universities of Chicago and Cincinnati. Mem. ASME, 1949. Mr. Mackey was a specialist in the architectural and civil-engineering section of the du Pont design division. He was a consultant for painting and protective coating. Mr. Mackey had been with du Pont since 1933. He had worked in various engineering, consulting, and supervisory capacities for the company's engineering service division, design division, and construction division. During World War II, he was with the Utah Ordnance Depot for a short time. He also worked in Brazil and Argentina. Mr. Mackey was a licensed professional engineer in Delaware. He was a member also of Pi Tau Sigma. Survived by his widow, Dorothy; daughter, Marilyn; mother, and a sister.

Alfred Augustus Markson (1902–1958), assistant vice-president, Hagan Chemicals & Controls, Inc., Pittsburgh, Pa., died Nov. 23, 1958. Born, New York, N. Y., 1902. Parents, Harry A. and Jane (Manheim) Markson. Education, CE, Rensselaer Polytechnic Institute, 1924. Married Marie L. Robbins, 1926; children, John and Alfred. Assoc. Mem. ASME, 1925; Mem. ASME, 1940. Mr. Markson had been with the Hagan firm since 1942. He held over 25 patents, and was the author of several papers on the development of steam-generation equipment. Recently, he had been conducting studies dealing with nuclear-reactor physics. Prior to joining Hagan, Mr. Markson was a research engineer at Consolidated Edison. He was a member also of ISA, and was a registered professional engineer in the States of Pennsylvania and New York.

James Arthur Middleton (1908–1958), engineering assistant to vice-president, Manufacturing Div., D-X Sunray Oil Co., Tulsa, Okla., died Dec. 26, 1958. Born, Oakland, Calif., Feb. 3, 1908. Education, BS(ME), University of Arizona, 1932. Mem. ASME, 1958. He was a registered professional engineer in the State of Oklahoma.

Henry Simmons Morse (1874–1958), planning engineer, Monsanto Chemical Co., St. Louis, Mo., died June 19, 1958. Parents, Worcester Harris and Drusilla (Bannister) Morse. Education, BS, Central Wesleyan College, 1895; hon. MS, 1899; BS(ME), University of Missouri, 1899; ME, 1905. Married Minnie Paulsmeyer, 1900; one daughter, Jewell Anna Morse. Married 2nd, Miss Major, 1940. Mem. ASME, 1918. Mr. Morse had been a specialist in design of equipment for the manufacture of chemicals. Survived by his widow.

David James Purdie (1882–1959), consultant, Builders-Providence, Inc., Div., B-I-F Industries, Inc., died Jan. 7, 1959. Born, Willimantic, Conn., Jan. 9, 1882. Education, BS(ME), Brown University, 1911. Assoc. Mem. ASME, 1921. Mem. ASME, 1935. Mr. Purdie joined B-I-F Industries when he finished school, and in 1955 became a consultant to the company. Member also Tau Beta Pi and Sigma Xi.

Carl David Smith (1879–1958), retired plant engineer, Federal Glass Co., Lancaster, Ohio, died Nov. 28, 1958. Born, Cornville, Maine, Jan. 12, 1879. Parents, Alonzo and Mabel (Cayford) Smith. Education, BS, University of Maine, 1905; Washington University. Married Olive Wallace, 1911. Married 2nd, Irene Weirich, 1924. Married 3rd, Irma Metcalfe Polling, 1939. Mr. Smith had been with Federal Glass as furnace-design and fuel engineer. He held a patent for a gas reversing valve. He was a registered professional engineer in the State of Ohio. Survived by his widow; and four daughters, Mrs. Dorothy Dicks, Mrs. Thelma Pearce, Mrs. Marjery Bethard, and Mrs. Wanda Lee Pierce.

William Rayner Straus (1889–1958), mechanical and electrical engineer, City of Baltimore, Baltimore, Md., died Nov. 21, 1958. Born, Baltimore, Md., June 30, 1889. Education, ME, Cornell University, 1910. Assoc. Mem. ASME, 1913; Mem. ASME 1923.

Richard Hume Tingey (1906–1958), technical manager and nuclear-power manager, Bethlehem Steel Co., Shipbuilding Div., Duxbury, Mass., died Sept. 7, 1958. Born, Winthrop, Mass., Sept. 6, 1906. Parents, Thomas Hume and Alice (May) Tingey. Education, BS(Naval Arch. and Marine Engng.), Massachusetts Institute of Technology, 1927; attended Lowell Institute, evening session, received diploma in EE, 1932. Married Mildred C. Lundgren. Mem. ASME, 1939. Mr. Tingey had been author or coauthor of a number of papers on the subject of marine engineering. He was a member of SNAME and Sigma Xi. He had been one of the original members of the ASME Nuclear Engineering Committee, now the Nuclear Engineering Division. Survived by his widow, and three children, Thomas H., Priscilla N., and Florence Tingey, all of Quincy, Mass.

James Wilson Vaughan, Jr. (1897–1958), president and treasurer, J. W. Vaughan Co., Greenville, S. C., died Dec. 19, 1958. Born, Cartersville, Ga., June 19, 1897. Parents, James Wilson and Sarah Frances (Williams) Vaughan. Education, BS(EE), Georgia School of Technology, 1918. Married Gladys White, 1921; three children, Harriet Elizabeth, Martha Jane, and Gladys White. Mem. ASME, 1936. During World War I, Mr. Vaughan served in the U. S. Army with the rank of second lieutenant. He had been a specialist in the application of power to production, particularly in textile-finishing processes.

Jacob Diller Wilson, Jr. (1907–1957), whose death in August, 1957, was recently reported to the Society, had been president, American Elevator & Machine Corp., New York, N. Y. Born, Brooklyn, N. Y., April 25, 1907. Education, EE, Cornell University, 1932. Mem. ASME, 1942. Mr. Wilson had joined American Elevator & Machine Corp. in 1926 and had been with the corporation until his death with the exception of one year. He was a registered professional engineer in the State of New York.

Harold Oakley Woolley (1885–1958?), retired chief engineer, Steam Div., Foster Wheeler Corp., died recently according to a report received by the Society. Born, Hartford, Conn., Nov. 15, 1885. Education, ME, Stevens Institute of Technology, 1907. Married Dorothy E. Bacon, 1913; two sons, Harold Oakley and Warren Stocker Woolley. Assoc. Mem. ASME, 1909; Affiliate ASME, 1915; Mem. ASME, 1935. Mr. Woolley was a registered professional engineer in the State of New York. Survived by his widow, Dorothy E. Woolley, Stuart, Fla.

John Elliott Younger (1892–1958), head, department of mechanical engineering, University of Maryland, College Park, Md., died December, 1958. Born, Canyon, Texas, March 7, 1892. Parents, James B. and Mary Ella (Elliott) Younger. Education, West Texas State Teachers College, 1912; attended University of Texas; BS(ME), University of California, 1923; MS, 1924; PhD, 1925. Married Nancy Brunette Francis, 1919. Mem. ASME, 1938. Dr. Younger was 1941 recipient of the Spirit of St. Louis Gold Medal for his outstanding contributions to aviation. He was in charge of technical research for the world's first all-metal-type plane developed at Wright Field in 1927–1928. He studied aeronautical developments in a round-the-world tour in 1936, lectured before the Royal Aeronautical Society of Great Britain in 1938, and was engaged by the Brazilian Government to advise on the organization of educational programs in aviation in 1947. Before assuming his post at the University of Maryland, Dr. Younger served at the University of California and had taught also in the Philippine Islands. Dr. Younger was author or coauthor of a number of books in his field, among them the first book on all metal monocoque. He served during World War I as a second lieutenant in the U. S. Army. He had been a member of SPEA and the American Association of University Professors. He was a fellow of the Institute of the Aeronautical Sciences, and had been a member of Tau Beta Pi and Sigma Xi. Dr. Younger had served the Society as executive secretary of the Aviation Division during the period 1943–1947. Survived by his widow; a daughter, Mrs. Nancy E. Vaughan; a son, John F. Younger, Dillon, Colo.; two sisters, a brother, and a grandson. ●

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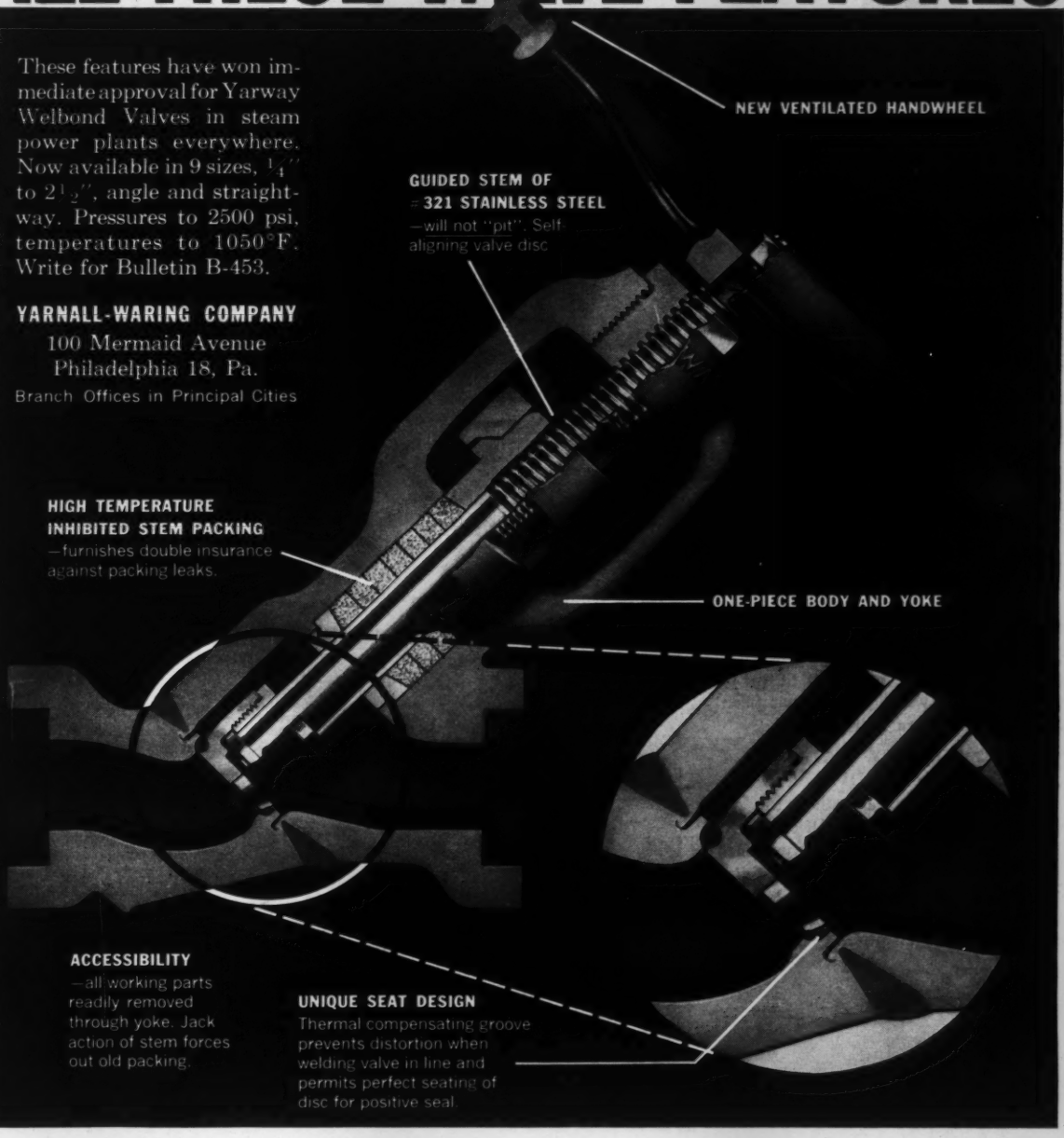
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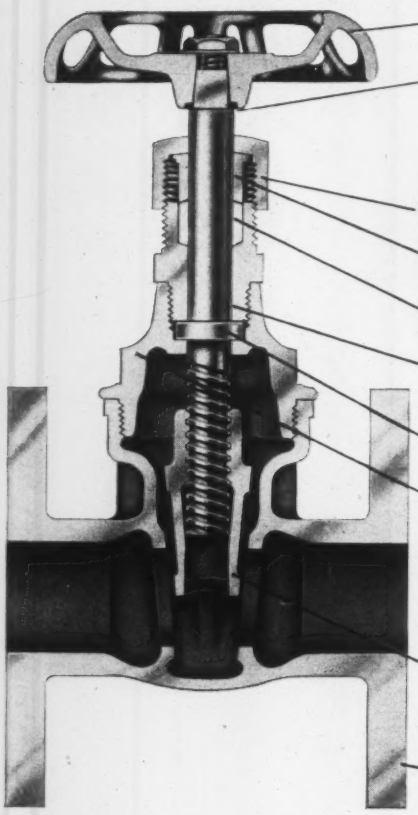

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Combustion Engineering, Inc.—20-page brochure describes and illustrates the design, construction, advantages, and economies of the La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications.

2 HIGH-STRENGTH STEELS

United States Steel Corp.—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing, for high-strength steels. The book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection.

3 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—Catalog 150 illustrates and describes solid roller bearings, wound roller solid race and split race bearings, industrial inch bearings and solid roller bearings in separable inner race, separable outer race and nonseparable types.

4 BUTT WELDING PIPE FITTING

Bonney Forge & Tool Wks.—Literature describes a forged, integrally reinforced, insert butt welding pipe fitting specially designed for applications on high yield pipe in the oil and gas transmission industries. The Sweepolet is reported to provide optimum reinforcement, maximum efficiency of metal placement with minimum weld.

5 SPRAYING NOZZLES

Spraying Systems Co.—Catalog No. 24, a 48-page reference book, covers nozzles and accessories for industrial and chemical spray applications. Nozzles are listed in tabular form and information is given on pipe sizes, external dimensions, orifice diameters, capacities, spray angles and spray patterns.

6 COMPRESSOR VALVES

J. H. H. Voss Co.—Bulletin 53-G covers valves for air, gas or ammonia compressors. The valves are machined from solid stock; plates are machined and ground; valves and plates are of heat treated alloy or stainless steel and are Custom designed to fit the indlvidual characteristics of the compressor for which they are manufactured.

7 HYDRAULIC MACHINERY

Watson-Stillman Press Div., Farrel-Birmingham Co.—A 24-page bulletin gives information on injection, compression, and transfer molding machines for the plastics industry; extrusion presses for ferrous and nonferrous metals; metalworking equipment; railroad shop equipment; ordnance equipment; standard and special machinery for general industrial applications.

8 HIGH EFFICIENCY FANS

Clarage Fan Co.—A new line of high efficiency fans, incorporating an advanced airfoil backward curved blade design, is described in Catalog 859. The Dynafoil fans are designed for mechanical draft, industrial processes, conduit type air conditioning, tunnel ventilation, and other heavy-duty applications.

9 VINYL PIPE

A. M. Byers Co.—PVC pipe catalog contains new corrosion resistance ratings, expanded information on abrasion resistance, thermal compensation, vacuum service. It includes dimensional and temperature vs. pressure data for Schedule A tubing. Sections describing installation procedures and applications have been enlarged. Diagrams illustrate methods of joining PVC pipe to other materials.

10 REFRIGERATING MACHINE

American-Standard Industrial Div.—Bulletin 1426, a catalog describing the Tonrac single-stage hermetic centrifugal refrigerating machine, shows in cutaway construction details, including condenser, single-stage compressor, marine type water boxes, evaporator, tube bundle, float valve, lubrication system, motor and purge system.

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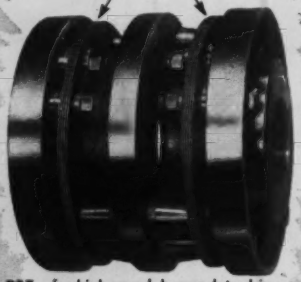

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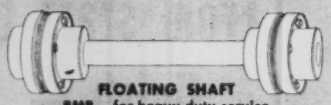

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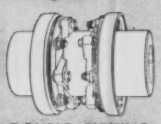

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YOUR New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

11 COMPRESSOR CONTROL SYSTEM

Ingersoll-Rand.—Form 3259 describes the firm's automatic Tendamatic compressor control system. The system "watches" all pressures and temperatures. In case of compressor malfunction or mechanical failure it identifies its nature, gives audible and visible warnings, and shuts down the compressor if the condition might reach the danger point.

12 DATA PROCESSING

Consolidated Electrodynamics Corp.—Technical bulletins describe MicroSADIC analog-to-digital conversion equipment, recording oscillographs, amplifying systems, and direct-writing oscillographs. Operating information and description of applications are also included. Bulletin Nos. 3004, 1585A, 1536B, 1500D, 1598B, 1522D, and 1589 are offered.

13 THERMOCOUPLES

Aero Research Instrument Co.—An enlarged data catalog describes AerOpak thermocouples for users in the nuclear, aircraft, industrial, and process fields. Temperature ranges from 400 to 2000 F; diameters are .025 to .313 in. The units can be bent to shapes and weldments can be performed directly on the thermocouples which are pressure tight to 50,000 psig.

14 SPUN STEEL TUBING

American Cast Iron Pipe Co.—Illustrated 64-page catalog describes special products division facilities, the centrifugal spinning process, its advantages and illustrates versatility of application of tubes. It contains tables, technical data, engineering information for stainless and carbon steel tubes 2.25–50 in. OD.

15 STEAM TURBINES

Terry Steam Turbine Co. Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multi-stage; Terry gears which are used for speed increasing and speed reducing.

16 LEAD PENCILS

Eberhard Faber Pencil Co.—Four-color catalog sheet describes and illustrates new, improved Microtomic drawing pencils. It also features Race Kleen, Pink Pearl, and Rubkleen erasers, describing their uses by artists, draftsmen, and architects.

17 SOLID, TUBULAR EXTRUSIONS

Babcock & Wilcox Co., Tubular Products Div.—Bulletin TB-413 tells of the division's tubular and solid extruded shapes, lists extrudable steels, high alloys and nonferrous metals and briefly explains the process, size ranges, dimensional tolerances and advantages of the use of extruded solid or tubular sections.

18 VALVES

Ledeen Mfg. Co.—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas or water powered. Bulletin gives operating and flow cycles, dimensions and weights.

19 SCRAPED SURFACE EXCHANGERS

Henry Vogt Machine Co.—Bulletin PE-1 describes the operation and application of these units for use as chillers, crystallizers, and heaters. Also shows sectional drawings, typical assemblies, and list uses.

20 ALLOY STEEL PIPE

U. S. Pipe & Fdry. Co., Steel & Tubes Div.—Bulletin illustrates and describes turned and bored, metal mold, centrifugally cast alloy steel pipe. Case histories are given, along with a description of the manufacturing process.

21 WELL WATER SYSTEMS

Layne & Bowler, Inc.—Bulletin 100 contains case histories and application photos of well water systems, pumps, shutter screens, special drilling applications featuring vertical turbine pumps.

22 VERTICAL FOUR-SLIDE MACHINE

Torrington Mfg. Co.—Bulletin V-82 details operating features, specifications for new Verti-Slide all-purpose vertical four-slide machine. Design details and component functions are given for feed mechanism, cam and cam shafts, drive system, and presses. Photos illustrate operation of slides, slide bases, center former, lubrication system, and clutch.

23 CAST STEEL VALVES

Ohio Injector Co.—Eight-page brochure lists information on cast steel gate, globe, angle, and check valves. It also identifies various designs available in forged steel gates in union and bolted bonnets, inside screw. Globes and angles are also listed.

24 UNDERGROUND PIPE INSULATION

American Gilsonite Co.—A four-page bulletin gives tips on the uses and installation of a new insulation for hot underground pipes. It explains how the material protects pipes against corrosion caused by acids and alkaline ground waters, and against bacterial action, roots and electrolysis.

25 INDUSTRIAL EQUIPMENT

Allis-Chalmers Mfg. Co.—Booklet 25B6057A makes reference from A to Z to literature available on the wide variety of products produced by the company. Capital goods equipment for almost every industry, in addition to construction and agricultural equipment, is covered, ranging from absorption machinery to zeolite softeners.

26 MULTI-V DRIVES

Worthington Corp.—A 100-page master engineering manual presents a scientific and simplified method for rating V-belts. Tables on drive selection contain nearly every possible stock sheave combination. Information on products and range of stock size sheaves with bore limitations is included.

27 COPPER TUBING HANGERS

Grinnell Co.—A 12-page catalog, CTH-56, covers hangers and supports for copper tubing. All hangers are copper plated and accurately sized to fit standard copper tubing. Data is also included on packaged quantities.

28 X-RAY GAGE

Sheffield Corp.—The Measuray, a non-contact X-ray gage for measuring the thickness of metals or nonmetals in strip or sheet while in motion or stationary, is described in Catalog No. AU-113-57. Materials checked include hot or cold strip steel, brass, copper, aluminum, plastics, foils, coated fabrics, films, rubber.

29 GEAR REDUCERS

Western Gear Corp.—Bulletin 5802 covers a line of SpeedMaster, parallel shaft type gear reducers. Engineering information is offered on single, double, and triple reduction reducers together with selection instructions. The reducers are offered in any reduction ratio desired with ratings up to 10,000 hp.

30 STAINLESS STEEL FITTINGS

Ladish Co.—An 86-page master reference volume on stainless steel pipe fittings gives information on broad line of IPS and tube OD fittings, ASA, MSS and corrosion weight flanges. Technical section includes manufacturing standards, specifications, corrosion resistance tables, and data on welding of stainless steel.

A world of facts at your finger tips. Use coupon on page 152 for free catalogs you need.

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New Catalogs GUIDE

31 BLAST CLEANING UNITS

Pangborn Corp.—Bulletin 705 describes new heavy duty Rotoblast barrels. Features and dimensions ranging from 20 to 102 cu ft capacities, available for all production cleaning requirements. The Rotoblast wheel, throwing up to 60,000 lb of abrasive per hour the abrasive reconditioning system, and other features are covered.

32 SILICONE RUBBER COMPOUNDS

Acushnet Process Co.—Literature describes silicone rubber compounds and expanded services for the molding of precision parts now available from the company. Increased service temperatures to 500 F and for limited periods to 600 F are offered by five new compounds. Three compounds with low shrinkage characteristics in the 50 to 70 durometer range permit molding of parts and holding of close tolerance in existing tools.

33 BEARING CUPS, CONES

Timken Roller Bearing Co.—An illustrated brochure tells how the company's continuous high-speed production methods at its Bucyrus, Ohio plant is holding down bearing costs and explains how manufacturers can benefit from these economies. Includes price index history demonstrating what these economies mean to the automotive industry. Back cover chart shows the 30 bearing cups and cones in the Green Light series which covers bore sizes from .7500 to 2.625 in.

34 BELT CONVEYORS

Transall, Inc.—Four-page brochure outlining the advantages of Transall prelubricated belt conveyor idlers. A check point list is included.

35 PLASTIC RESINS

E. I. duPont de Nemours & Co.—Catalog A-7345 illustrates and describes characteristics, forming and working techniques and end-use applications of Teflon tetrafluorethylene resins, Zytel nylon resin, Alathon polyethylene resins and Lucite acrylic resin. Detailed properties charts are listed.

36 HYDRAULIC FLUID

Shell Oil Corp.—A technical bulletin covers Irus fluid 902, a fire-resistant fluid for hydraulic applications. Information is given on safety and tests, operating advantages of the fluid, preparation and maintenance of hydraulic systems.

37 CHAINS, SPROCKETS

Diamond Chain Co.—Catalog No. 759 covers the firm's standard products and gives specific engineering data on chain selection, horse power ratings, chain and sprocket recommendation sizes.

38 STEAM GENERATORS

Erie City Iron Works.—A 20-page general catalog, SB60, describes steam generators and allied equipment. Cross section views of each class of water and fire tube boilers and stokers are included, along with data on packaged boilers for oil, gas, or stoker firing, custom-designed steam generators for largest industrial steam demands and oil, gas, and coal firing equipment.

39 HOLLOW SHAFT REDUCERS

Winsmith, Inc.—Twelve-page illustrated catalog covers new double reduction hollow shaft worm gear speed reducers in Series "STD" torque arm and Series "SFD" flange mounted types. They cover an output range from 0.041 to 2.552 hp, a ratio range from 66-$^{3}/_{13}$ to 4466 : 1, and a maximum output torque range of 1380 to 7678 in-lb.

40 AXIAL FLOW PUMPS

Allis-Chalmers Mfg. Co., Hydraulic Div.—Axial flow pumps of adjustable and fixed blade types are described in Bulletin 165. They are applicable for heads ranging from 5 to 55 ft and have been built in sizes from 11 to 150 in. in diameter with discharges from 3000 to 900,000 gpm. Bulletin includes typical settings, preliminary sizing data, specifications, and pump-turbine application.

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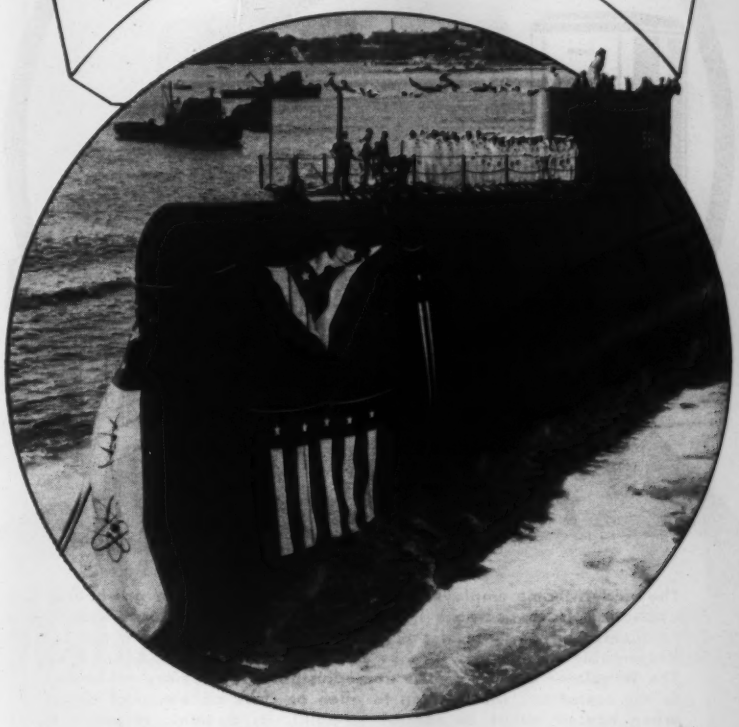

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If all the homes in the world containing equipment protected by Chace Thermostatic Bimetal were lined up side by side, we're reasonably sure you'd have a Main Street reaching around the globe. We're proud that Wilcolator recognizes the Chace contribution to the safety and dependability of these millions of appliances, joining the hundreds of manufacturers who have benefited from Chace's precision methods in our third of a century of thermostatic bimetal production. Chace's creed: "Uniformity, uniformity, uniformity" is Wilcolator's assurance that no appliance employing their product will fail in the performance of its duty.

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YOUR *New Catalogs* GUIDE

41 BRONZE BEARINGS

Bunting Brass & Bronze Co.—Catalog 58 lists 866 sizes of standard stock cast bronze bearings, 667 sizes of plain, flange and thrust sintered oil-filled bronze stock bearings, 267 sizes of cast bronze tubular and solid 13-in. bars, and 84 sizes of sintered oil-filled bronze 6-in. bars.

42 SPRING PINS

C. E. M. Co.—Catalog lists prices, dimensions, technical information on heavy, medium, and light duty Spirol spring pins in carbon steel, chrome stainless steel, and nickel stainless steel. Typical applications are illustrated.

43 POWER TRANSMISSION EQUIPMENT

Twin Disc Clutch Co.—Bulletin 314 describes line of mechanical and hydro-kinetic drives. Torque, horsepower, and dimensional data for mechanical, air hydraulic, and electrical clutches, fluid couplings, single and three stage torque converters, and marine reverse gears.

44 TORSIONAL VIBRATION DAMPER

Houdaille Industries, Inc., Buffalo Hydraulics Div.—A brochure describes the operation and use of viscous torsional vibration dampers. It includes a data sheet required to apply this damper to internal combustion engines and rotary systems likely to have critical speeds in the operating range. The damper is untuned and said to provide highly efficient damping even when damper is not optimum for the system.

45 BALL BEARING SWIVEL JOINTS

Chiksan Co.—A revised 32-page catalog, G-4R covers the company's line of ball-bearing swivel joints, loading racks, manifolding lines, all-metal marine and barge hose, and flexible aircraft assemblies. Typical industrial applications are illustrated and dimensional and operating data is provided.

46 CLAD STEEL EQUIPMENT

L. O. Koven & Bro., Inc.—A booklet gives data on the development of properties, types, testing, design considerations, fabrication, and applications of clad steels. Another booklet covers the cleaning and maintenance of clad steel equipment.

47 PNEUMATIC CONVEYING SYSTEM

Spencer Turbine Co.—Bulletin No. 143-B describes stationary and portable pneumatic conveying systems. Systems cover a capacity range from ¾ through 10 tons per hour; vacuum producers from 5 through 75 hp, and hose or pipe sizes from 2 through 7 in.. Conveying under both pressure and vacuum is covered, and applications are illustrated.

48 VIBRATION TEST MACHINES

All American Tool & Mfg. Co.—Catalog F describes five new models of vibration fatigue testing machines equipped with electronically controlled drive motors and automatic range selector for variable acceleration control. Units are said to provide infinite frequency control within the range of 5 to 100 cps, recorded on an electric tachometer.

49 THREAD INSERTS

Heli-Coil Corp.—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts.

50 DUST, FUME COLLECTORS

Northern Blower Co.—Bulletin 164 describes automatic bag type arresters, diagrams standard dimension factors and supplies table of dimensions and capacities. Separate additional bulletins contain similar data for standard bag type (not automatic), hydraulic type, centrifugal type, and portable dust collectors.

51 PRESSURE TRANSDUCERS

Pace Engineering Co.—Four-page catalog describes a line of magnetic reluctance pressure transducers and includes detailed performance specifications. Typical associated equipment and recording systems are described.

YOUR

New Catalogs GUIDE

52 O-RINGS

Linear Inc.—Compact 20-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

53 CONVEYOR-ELEVATORS

Stephens-Adamson Mfg. Co.—Catalog 358 illustrates the firm's line of conveyors, elevators. Typical arrangements are diagrammed; power requirements, specifications and installation data is given. Applications in various industries are illustrated and described.

54 NEEDLE THRUST BEARINGS

The Torrington Co.—Catalog 759 covers needle thrust bearings with increased capacity ratings. It discusses installation, lubrication, and load capacity of the bearings and design and installation of the thrust races for use with them.

55 STAINLESS AND HIGH ALLOY PIPE AND TUBING

Trent Tube Co., Subsidiary of Crucible Steel Co. of America—A 48-page manual detailing the complete operation of Trent Tube, manufacturers of Contour Trentweld, stainless steel and high alloy pipe and tubing. Included is information on Tubing Classifications—plus charts and tables applying to each class. Corrosion characteristics, weights, properties of alloys and conversion tables are also included.

56 HEAT EXCHANGERS

Southwestern Engineering Co.—A catalog describes heat exchangers and pressure vessels which are designed, engineered, and manufactured for the process and power industries. Photographs and diagrams illustrate basic types and other special process and power equipment such as feed water heaters, surface condensers and steam jet ejectors.

57 SUPER REFRACTORIES

Carborundum Co., Refractories Div.—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

58 OIL FILTERS, STRAINERS, OILING DEVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins. No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

59 WORM GEARING

Cone-Drive Gears Div., Michigan Tool Co.—Double-enveloping worm gearing, supplied in individually matched sets, providing high load-carrying capacity on small center distances, is detailed in 16-page Bulletin 700-C. Included are specification drawings for all worms and gears, tool charts and horsepower ratings for hundreds of special gearset combinations, backlash tolerances, lubrication data, and service factors.

60 COUPLINGS

Snap-Tite, Inc.,—Four bulletins and various data sheets cover couplings for high pressure systems, gravity flow systems, vacuum systems and hydraulic systems. Cutaway photos, diagrams and flow charts are included in the literature.

61 ANTI-FRICTION BEARINGS

Industrial Tectonics, Inc.—Design requirements for anti-friction bearings of unusual shapes and sizes, and current information on suitable bearing component materials for high-temperatures, corrosion resistance, nonmagnetic properties, and other specialized operating conditions, are described in Bulletin AFB-2.

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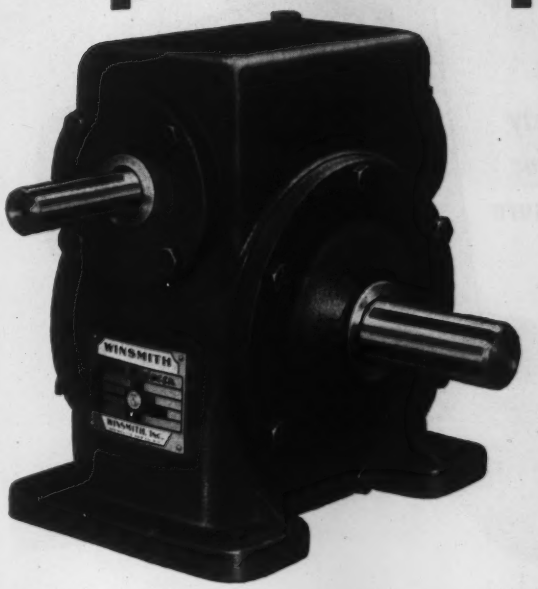
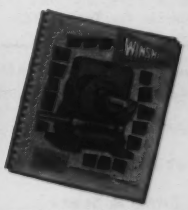


Winsmith worm gear speed reducers

For top performance on your big jobs, Winsmith Worm Gear Speed Reducers are available for any application up to 34 horsepower. Compact, efficient, economical — with endurance to spare — Winsmith Speed Reducers offer you the most complete line of standard models, sizes and drive arrangements from a single source. For speed reducer requirements all the way down to 1/100 hp, you'll find it pays to specify Winsmith.

WINSMITH SPEED REDUCERS

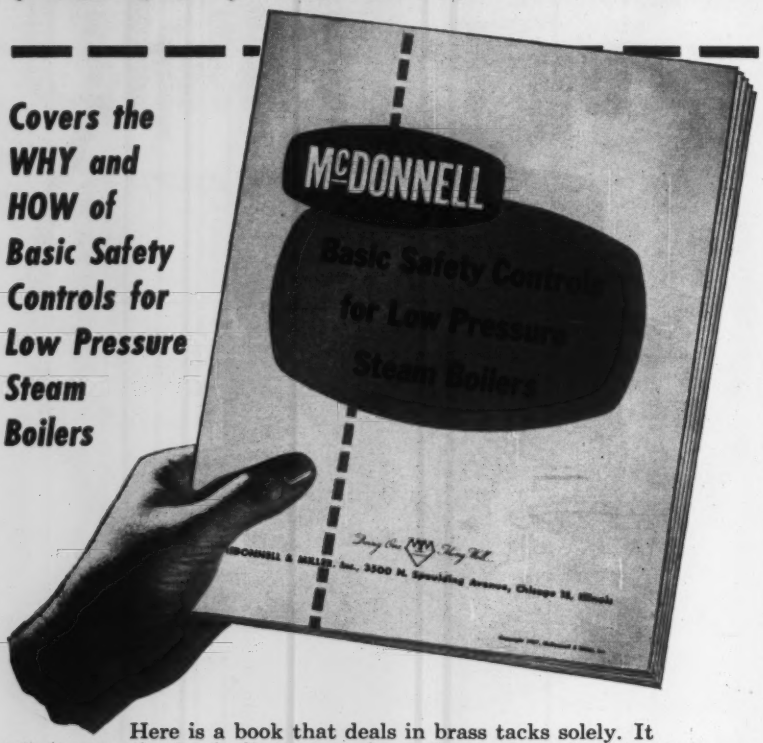


WRITE TODAY FOR CATALOG NO. 155 for useful information on selection, operation and maintenance of the hundreds of sizes and types of Winsmith Speed Reducers

WINSMITH, INC. 20 Eaton Street, Springville, (Erie County), N. Y.

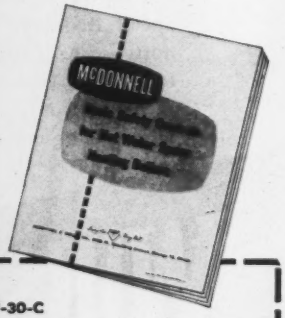
NEW BOOK THAT CAN DO A JOB FOR YOU!

Covers the WHY and HOW of Basic Safety Controls for Low Pressure Steam Boilers



Here is a book that deals in brass tacks solely. It tells its story in simple diagrams and equally simple explanation that wastes no words on product description. It sticks to fundamentals and concrete recommendations that answer practically all safety control problems encountered in the low pressure steam field. So well classified and indexed are the facts that, whatever your job, you can turn right to the most authentic way of handling it: The right product . . . the correct hook-up . . . the proper wiring. *Use the coupon to request your copy*, and if you do not have the earlier "hot water" booklet, request it too.

This new "Low Pressure Steam" booklet was inspired by the widely praised booklet on "Hot Water Boilers." These two companion-pieces can do a real job for you.



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Boiler Water Feeders • Low Water Fuel Cut-Offs • Pump Controllers • Flow Switches • Relief Valves • Related Liquid Controls for Tanks, Stills, Air Conditioning Systems

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YOUR *New Catalogs* GUIDE

62 MANUAL, SOLENOID VALVES

Barksdale Valves.—Catalog 59-60 covers manual, foot-operated, and solenoid valves. Manual and foot-operated valves are 4-way, shut-off, manipulator, and dual pressure. Solenoid models include 4-way, 3-way, shut-off and diverter valve series.

63 AUTOMATIC PACKAGE BOILER

Bituminous Coal Institute.—Specifications GS-3 covers application of IBW-BCR Caol-Pak automatic package boiler to low-pressure steam heating, hot water heating, and high-pressure process steam for plant designs using one 71.6-hp unit to a multiple of 300-hp units. Sample specifications include coal and ash handling, wiring, and boiler room layouts.

64 METAL HOSE

Flexonics Corp.—A 36-page design catalog covers application and selection of metal hose. Various end fittings are illustrated and described.

65 O-RING DATA

Federal-Mogul-Bower Bearings, Inc.—Catalog 204 gives engineering, selection, and application data on O-rings. Physical properties are detailed and a section gives sizes and cross reference. It includes a list of the firm's field offices.

66 METAL CONSTRUCTION

Pittsburgh-Des Moines Steel Co.—A 36-page general brochure describes the capabilities and diversities of engineering, research, fabrication and construction of steel, stainless steel, stainless clad steel, alloy, and aluminum.

67 ELECTRONIC DATA PROCESSING

ElectroData Div., Burroughs Corp.—Eight-page Brochure No. 5220, describes latest electronic computing system designed for engineering, scientific and commercial applications. Details are given on speeds, programming, expandability, and filing capacities. Magnetic tape, paper tape, and punched card facilities available with this medium-price digital system are summarized.

68 AIR COMPRESSORS

Ingersoll-Rand.—Form 3250 describes the new ESH (horizontal) and ESV (vertical) standard plant air compressors. Available in sizes from 20 to 150 hp, the units feature completely sealed frames, full-floating aluminum bearings, air-cushioned channel valves and full force-feed lubrication. They are adaptable to any drive.

69 GENERATORS, BOILERS

Wickes Boiler Co.—Bulletin 55–1 gives information on the facilities and products of the company including drawings of typical steam generators and shop-assembled water tube boilers. Units shown from 15,000 lb capacity of steam per hour to 300,000, designed to operate to 1000 psi. Duotherm vaporizers, economizers, superheaters, and airheaters are included.

70 COPPER ALLOYS

American Brass Co.—An enlarged edition of its "Copper & Copper Alloy Specifications Index" lists the most generally used alloys and products of the company, together with the applicable specifications of the eight following agencies: ASTM, ASME, AWS, SAE, AMS, Federal, Military, and Joint Army-Navy.

71 FEEDERS, CONVEYORS

Jeffrey Mfg. Co.—Catalog 930; 96 pages, covers electric vibrating feeders and conveyors. Controls, installation methods, principles of operation and individual unit specifications are included. Other vibrating equipment such as barrel packers, coolers and dryers, magnetic separators and bin level indicators are covered.

72 CHEMICAL PUMPS

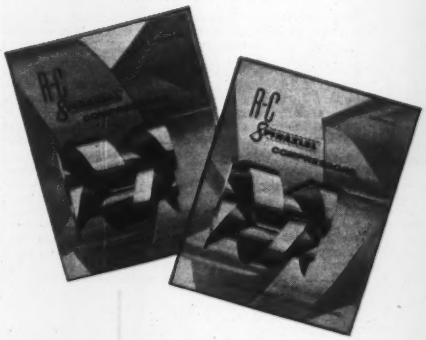
Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 137 illustrates and describes Type SVC pump, developed for efficient and economical transfer of hydrocarbons, chemical solutions, acids, and condensates in process installations. The water cooled, centrifugal pump has temperatures to 800 F, capacity from 15 to 3000 gpm at a working pressure of 600 psig, a differential head of 700 ft and speeds to 4000 rpm.

HIGHER RATINGS

Increase Efficiency of R-C Spiraxial Compressors

R-C Type LAL Spiraxial Compressors are available in capacities up to 5000 cfm and for discharge pressures up to 30 psig as single-stage units.

R-C Type LAH Spiraxial Compressors are available in capacities up to 12,000 cfm and for discharge pressures up to 15 psig as single-stage units.



For additional data, please refer to pages 565-568 in **Chemical Engineering Catalog,** *our section in* **Mechanical Catalog** *or write for* **Bulletins LAH-158** *and* **LAL-458.**

The famous R-C Spiraxial® Compressor is now offered in two pressure ranges – both with increased efficiency and higher ratings.

The Type LAL for pressures to 30 psig has been serving efficiently and economically in a wide variety of applications. Its *efficiency* and *economy* have been proved by 24-hour service for months on end at oil refinery installations. The unit has helped increase throughput to such an extent that one-year's run will pay for the installation.

With the new lower-pressure Type LAH for pressures to 15 psig, the efficiency and economy of R-C Spiraxial Compressors can now be gained in many new applications. Its *dependability* has been proved by its use in nuclear-powered submarines for ventilation exhaust and ballast blowing. Either Type LAL or LAH can be employed in parallel operation to increase capacities indefinitely.

The ability of Spiraxial Compressors to deliver oil-free, uncontaminated air or gas makes them ideal for such applications as aeration and agitation of fermentation vessels, pneumatic conveying, catalyst regeneration, process oxidation and many others.

The Spiraxial design which makes possible this broad range of applications is the result of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.

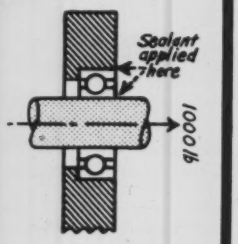
ROOTS-CONNERSVILLE BLOWER
DIVISION OF DRESSER INDUSTRIES, INC.
489 Michigan Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto

Edwin F. Oblinger, Chief Engineer, Parker Sweeper Company, says:

"WE THREW OUT PRESS FITS FOR BEARINGS..."

"We used interference fits to prevent bearing races from turning in the gear box of our 4HP Turbo-sweeper. Maintaining close tolerances was a constant headache. If the fit was loose, the race would slip and fret the surfaces; if the fit was tight, the race would deform and bearing life would be shortened. Then we discovered LOCTITE Liquid Sealant would do away with the need for press fits. We opened up the tolerances for both shaft and housing and used a slip fit, filling the clearance with LOCTITE. The bearings are retained with a force equal to the customary interference fit, but we've reduced rejected parts from 8% to less than 1% and reworked parts fell from 20% to 0! Field reports are excellent."

LIQUID SEALANT . . . replaced interference fits and opened up tolerances almost 0.002 in. on shaft and housing for this ball bearing assembly. Load of over 1000 lbs. is needed to break bond.



LOCTITE is a penetrating liquid that hardens only after being confined between closely fitted metal parts. In the absence of air, the sealant hardens into a strong, heat and oil-resistant bond. The hardening action may be accelerated by heating.

LOCTITE eliminates the need for interference fits on bearings, sleeves, shafts and studs . . . locks nuts to bolts, seals pipe and tubing joints. Write for literature and free sample.

LOCTITE® SEALANT

AMERICAN SEALANTS COMPANY

211 Woodbine St., Hartford 6, Conn.

See LOCTITE Booth 1653 Design Engineering Show

YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

73 SPECIAL SERVICE HOSE

Raybestos-Manhattan, Inc.—Manhattan Rubber Div.—Catalog M680 gives information on features, construction, sizes, fittings and materials used in special service hose. Application photos show the hose in use in various industries.

74 DIESEL, DUAFUEL ENGINES

Nordberg Mfg. Co.—A 16-page bulletin describes two-cycle, 21-in. bore, diesel, and Duafuel engines for stationary and marine service. The bulletin, No. 245, describes operating advantages of the Series 21 engine and includes views of utility, industrial power, and marine installations.

75 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—Catalog sheets illustrate and describe hand operated punches, cutters, and benders and list large, planned stock of punches and dies to fit most makes of punch presses. New, simplified system of decimal die marking is introduced with charts for determining correct clearance to allow for both type and thickness of metal being punched.

76 BOILER, TANK CONTROL

Commercial Shearing & Stamping Co.—Three catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; P-3 standard shapes which are available without tool and die charges; C-1, applications and advantages of stampings, forgings and assembled products.

77 THERMOCOUPLE SYSTEM CALIBRATOR

Pace Engineering Co.—A manual gives the theory and operation of equipment for calibrating multi-channel thermocouple recording systems. The calibrator is one in which the reference temperature and scale are established by injection of monitored voltages supplied by two mercury cells.

78 VALVE CONVERSION UNIT

C. H. Wheeler Mfg. Co.—A new automatic valve actuating conversion unit is described in Catalog V-200. It is called Valvmatic and converts hand-operated valves to motor operation without removing the valve from line or disturbing piping. It is actuated electrically, and will open and close windows and operate valves.

79 FLEXIBLE SHAFTING

F. W. Stewart Corp.—A bulletin covers Circle Ess flexible shafting. Included are specification charts on both remote control and power drive cables plus complete data charts casing materials. Uses of adapters for flexible shafting are also given.

80 TEMPERATURE CONTROLS

Fenwal Inc.—Detailed folders describe devices for temperature detection, indication and control. Included are Thermoswitch and snap action local controls, remote bulb and capillary units, Detect-a-Fire and electronic thermistor controllers.

81 LOADING ASSEMBLIES

Jordan Industrial Sales Div. of OPW Corp.—A 24-page Catalog F-32R describes loading assemblies and accessory products. The catalog contains detailed product descriptions and photos, engineering information, dimensional drawings, installation layouts, and selection instructions.

82 PIPING INSULATION MANUAL

American Gilsonite Co.—A 20-page booklet covers the methods of application of Gilsulate, a new insulation for hot underground pipes. It describes the three grades, how to determine ditch size for various pipes and types of soil, and gives sample problems.

83 VACUUM PUMPS

Leiman Bros., Inc.—A 16-page catalog, No. 758 describes rotary positive air and vacuum pumps, gas boosters and air motors. Included are 2 and 4 wing types; fan-cooled, water-cooled and new radiator air-cooled models; motor driven units; direct-coupled and belt-driven models, integral pump and motor; automatically controlled tank units; accessories.

84 NEW METHOD OF LUBRICATION

Stewart-Warner Corp., Alemite Div.—Catalog describes new method of lubricating industrial machinery with "Oil-Mist." Bulk of publication taken up with engineering data, covering applications, operation, bearing application, bearing speeds of this method. Also for plain bearings, selection of condensing fittings, intermixing of condensers, bearing grooving and many other engineering data appropriate to the subject.

85 PLASTIC PIPE FITTINGS

Grinnell Co.—A 16-page catalog on corrosion resistant pipe fittings, flanges, valves and pipe in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

86 ULTRASONIC MACHINING

Sheffield Corp.—How to use ultrasonic energy to cut, drill, emboss, engrave, slice, and dice hard and brittle metals and nonmetals is shown in publication No. CAV 7-56. The 16-page illustrated booklet describes the ultrasonic machining process, shows examples of designs and forms machined in carbide, glass, germanium, ferrite and ceramic, and also includes specifications and machining capacities of ultrasonic machine tools.

87 OIL AND GAS BURNERS

Ray Burner Co.—A new illustrated 16-page catalog gives specifications and capacities of commercial and industrial gas, oil, and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners; commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil inshot gas burners; forced draft packaged burners. Tables and other technical data are included to aid in selection.

88 CENTRIFUGAL PUMPS

Worthington Corp.—Bulletin 2131-B1 illustrates and describes 2- and 4-stage centrifugal pumps for boiler feed and general medium pressure services in pressures to 750 psi and capacities to 2500 gpm. Cross-section and dimensional diagrams of the units are included, along with information on writing specifications.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . and select those of interest to you. *Distribution by us to Students is not included.*

The coupon on page 152 must be mailed on or before May 15th.

YOUR

New Catalogs GUIDE

89 WELL SCREEN

Layne & Bowler, Inc.—Bulletin 900 covers improved Model 134 shutter screen for gravel wall wells. Specifications are included.

90 ELBOWS, FITTINGS

Midwest Piping Co.—A 20-page bulletin, No. 58-A, points out benefits from a unique method of manufacture employed in making elbows. Among these benefits are: greater strength than seamless pipe, exceptional dimensional accuracy and uniformity, greater variety of fittings including difficult specials.

91 MANUAL CHUCKS

Cushman Chuck Co.—Catalog No. 67-1959, with companion price list, contains listings and detailed engineering data on manually operated chucks for both older and new standard spindle noses.

92 SCRUBBER, PURIFIER

Centrifix Corp.—Bulletin 500 illustrates and describes the firm's WD scrubber for removing oil mist, acid fumes, dust and fly ash. Bulletin 600 covers the CD dry purifier for removing valuable materials entrained in any gas or air stream at any temperature without heat loss or the use of a wetting agent.

93 INSPECTION INDICATING GAGES

O-Vee Gauge Co.—Bulletin illustrates and describes new line of heavy rugged indicator gages with lever type amplification which provides greater reliability. Provision is made to enable gaging fixtures and stages to be made at low cost. Examples are illustrated in the bulletin.

94 PRECISION COMPONENT

PIC Design Corp.—New 416-page catalog lists with drawings and prices of 8000 stock parts for breadboard, development, and production. The catalog includes gears, differentials, speed reducers, shafts, gearings, couplings, breadboard, kits.

95 IN-LINE ENGINES

Nordberg Mfg. Co.—Bulletin 257A describes four cycle diesel, Duafuel and spark-ignition gas engines. Installations discussed include municipal and industrial power plants, pipe line pumping stations and marine propulsion and auxiliary service.

96 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—A 24-page catalog, illustrated with specifications on more than 500 types and sizes of standard miniature ball bearings from .059 in. to $^{1}/_{8}$ in. OD, includes applications, lubrication, design variations.

97 STAINLESS STEEL

Sharon Steel Corp.—A 32-page catalog offers description, chemical composition, strength factors, physical properties and applications for stainless steels, including the 200, 300 and 400 series. Forging ingots and rolled-in surface patterned stainless steels are included.

98 HUMIDIFICATION EQUIPMENT

Bahnson Co.—Catalog Section 104 details the firm's line of industrial humidification equipment. Information and pictures describe and show various types of steam and water humidification equipment. The different uses, capacity, function, and operation of each type is explained.

99 PISTON, SEALING RINGS

Koppers Co. Metal Products Div.—A 24-page brochure illustrates and describes American Hammered piston and sealing rings for various types of industrial applications. Also available are four-page folders on conformable oil ring, marine piston rings, chrome-plated piston rings, piston rings for air and steam forging hammers, Teflon rings, railroad piston rings, and an eight-page brochure on metallic sealing rings.

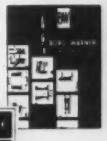
100 REFINERY PUMPS

Dean Brothers Pumps Inc.—Circular 201 describes new line of heavy duty centrifugal pumps for refinery and process service with top suction and discharge nozzles. Built to API and major oil company specifications, the units have capacities up to 1000 gpm. Pump sizes, mechanical design specifications, sectional view with parts list.

Name your most difficult shaft sealing problem, and you've named the best reason for using a Borg-Warner Mechanical Seal on that shaft.

The real practical value of Borg-Warner Seals is their ability to seal *effectively* under the toughest extremes of temperature and pressure ... for toxic, volatile or corrosive fluids ... and even some abrasive liquids. *Result*—less down time, elimination of leakage and expensive stuffingbox maintenance.

Borg-Warner Mechanical Seals



NOW AVAILABLE—a new file folder of Borg-Warner Mechanical Seal designs shows some of the many types and applications possible for mixers, pumps, compressors, autoclaves and for special rotating shaft problems. Send for your copy today—there's no obligation.

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Borg-Warner® Mechanical Seals

P. O. Box 2017, Terminal Annex, Los Angeles 54, California

PERFECTION
worm gear
SPEED REDUCERS
available in ratios of
5 to 1 to 60 to 1

Perfection Worm Gear Speed Reducers by American Stock Gear are available in 9 complete series with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute. Speed Reducers are furnished in horizontal right angle drive with worm in either top or bottom position and are also furnished in vertical right angle drive. Integral worm and shaft is made of selected quality, case hardened alloy steel. Threads are precision ground and accurately mated with worm gear. Shafts are mounted in Timken anti-friction roller bearings. Heavy rigid cast-iron housings . . . easily accessible oil filling level and drain plugs are provided for oil reservoir. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor.

Write for new 16 page catalog covering the complete PERFECTION Speed Reducer line.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY • HARVEY, ILLINOIS, U.S.A.

YOUR
New Catalogs GUIDE

101 FRICTION MATERIALS

Johns-Manville—A 16-page brochure, FM-35A, gives descriptions, design data, characteristics, and a reference chart of industrial friction materials including asbestos brake blocks, linings, and clutch facings.

102 SCREW DRIVING ACCESSORIES

Magna Driver Corp.—A 27-page catalog gives specifications, diagrams of various permanently magnetic screw holding accessories for power drivers, and nut setters. Also included are magnetic hand screw drivers, sockets, and screw driver bits.

103 ROTARY JOINTS

Seamlex Co.—Eight-page Bulletin 5500-B describes rotary joints for steam, water, and air. Information on mechanical construction, engineering features, operating results is included with diagrams illustrating three engineering principles responsible for triple protection against leakage.

104 DRAFT GAGES, INSTRUMENTS

Ellison Draft Gage Co., Inc.—Bulletin 354-A gives a briefing on the entire line of the company's bell actuated and diaphragm actuated draft gages, inclined tube draft gages, pitot tubes, gas analyzers, steam calorimeters and other boiler room and laboratory gages and instruments.

105 LUBRICANTS, COMPOUNDS

Shell Oil Co.—A series of folders gives data on properties, testing, applications of a new atomic power lubricating grease, an extreme temperature range lubricant for missile applications, an emulsion-type lubricant for large low-speed diesel engines, compounds and fluids for open gears under extreme pressure loads, and the company's oil-print analysis for field diagnosis of motor oils.

106 WELD TUBE MILLS

Yoder Co.—A 64-page handbook describes the use of modern tube mills in the manufacture of pipe and tube. A description of the electric-weld process and photos, drawings and charts on the operation, capacities, and applications of various mills are included.

107 STEAM GENERATORS

Ames Iron Wks., Inc.—Bulletin GB-1 describes how generators have helped solve boiler room problems. The advantages of compact, simple and efficient design of complete packaged boilers are shown being put to use in plants across the nation.

108 PLANT CONSTRUCTION

Nooter Corp.—Brochure describes, by example, the firm's field construction department for fabricating and erecting processing equipment for such industries as chemical, petroleum, brewing, food, pharmaceutical, and public utilities.

109 STRAIN GAGES

Electronics & Instrumentation Div. Baldwin-Lima-Hamilton Corp.—Catalog covers 250 types of bonded filament resistance strain gages. Electrical and physical specifications of each gage type are included, together with prices and quantity discounts. A separate section provides data on the selection of gages.

110 COMPRESSED AIR UNITS

Hankison Corp.—A 20-page catalog describes construction, operation and performance of compressed air units, combination condenser filter for instrument air, dehydrafilter for vapor-free air lines, condensate discharge trap.

111 ALLOY STEELS

Bethlehem Steel Co.—Booklet 415-C, includes such subjects as "What is an Alloy Steel?" "Effects of Elements," "Grain Size," "Heat-Treatment," "Determining Depth Hardness." It contains nine tables of AISI and SAE specifications for open-hearth and electric furnace alloy steels–bars, billets, blooms, and slabs.

112 PLASTIC SHIMS, GASKETS

Chicago-Wilcox Mfg. Co.—Form 570 gives characteristics on plastic shims, gaskets, and shim stock. Identification of thickness by number and color and results of testing the material is included.

YOUR

New Catalogs GUIDE

113 MECHANICAL-OPTICAL FACILITIES

Kollmorgen Optical Corp.—Bulletin 500 describes facilities for precision mechanical and optical manufacturing. It includes engineering and inspection equipment, plus narrative outlining company's activities in the fields of atomic energy, nuclear research and remote observation, with emphasis on industrial periscopes of which it is a prime supplier for government and commercial use.

114 PNEUMATIC TRANSMITTERS

Mason-Neilan—Bulletin No. 214 describes pneumatic transmitters for temperature and pressure applications in process control. Transmitters may be installed in any position without zero shift. Complete specifications and operational diagrams are included.

115 HEATING, AIR CONDITIONING

Surface Combustion Corp.—A 28-page brochure describes equipment engineered and built by Surface Pelletizing, Steel Mill, Heat Treat, Glass, Webster Engineering Co.—Boiler Burner, Kathabar Air Conditioning and Drying, Janitrol Aircraft and Janitrol Heating, and Air Conditioning divisions.

116 SELF-ALIGNING COUPLINGS

Koppers Co., Metal Products Div.—A 16-page brochure describes principles and features of Fast's self-aligning couplings. Illustrates and describes each available standard and special model. Also available are four-page folders on Model B, forged steel, cast steel, mill motor flex-rigid, and breaking-pin Jordan couplings.

117 TORQUE WRENCH SLIDE RULE

P. A. Sturtevant Co.—A slide rule for calculating conversion factor for torque wrenches used with adapters and extensions is offered. Range of rule covers practical torque wrench and adapter combinations for determination of proper conversion constant.

118 COPPER, COPPER ALLOYS

American Brass Co.—A 32-page reference booklet on corrosion resistance of copper and copper alloys covers continuous laboratory research and field study of the nature of corrosive attack on these metals conducted for a period of 31 years by the company's technical staff. Latest findings are incorporated in the text of Part I, "Theory of Corrosion and Types of Corrosive Attack."

119 FILTERS

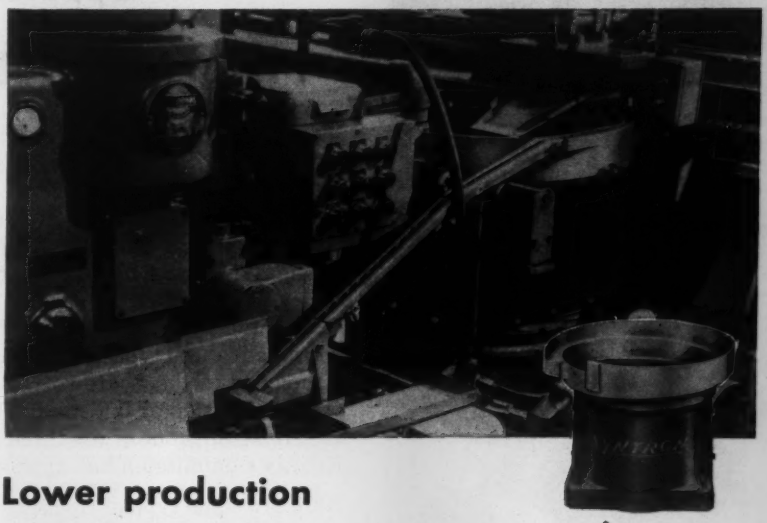
Air-Maze Corp.—General catalog describes entire line of air filters and liquid filters, including oil bath air filters for engines, compressors, blowers, heating and ventilating filters and electrostatic precipitators, all metal, cleanable liquid strainers offering down to 10 μ filtration, intake silencers, exhaust spark arresters.

120 STEAM SURFACE CONDENSERS

Maryland Shipbuilding & Drydock Co., Industrial Products Div.—A brochure describes products and experience of the company in the heat transfer and fabricated-machined component parts manufacturing capital equipment industry. Emphasis is on steam surface condensers.

Select desired Catalogs by number. Requests limited to 25 catalogs. Fill in coupon on page 152 and mail promptly.

SYNTRON Vertical Vibratory PARTS FEEDERS



Lower production costs by reducing parts handling costs

SYNTRON Parts Feeders automatically orient and feed small parts of almost every size, shape and material to automatic machines, such as shown in photo above, at instantly controlled rates of flow to match production line speeds—without breaking or damaging parts. They are easily adaptable to most operations by the use of gravity feed tracks that deposit parts where and as they are needed.

Working on an electromagnetic principle eliminating motors, gears, bearings, and etc.—SYNTRON Parts Feeders assure less down time and lower maintenance.

SYNTRON can help with all your parts handling problems—

Write for illustrated brochure—FREE

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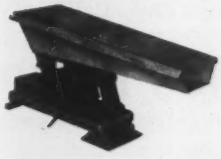
498 Lexington Avenue Homer City, Penna.

Other SYNTRON Equipment of proven dependable quality

FLOW CONTROL VALVES

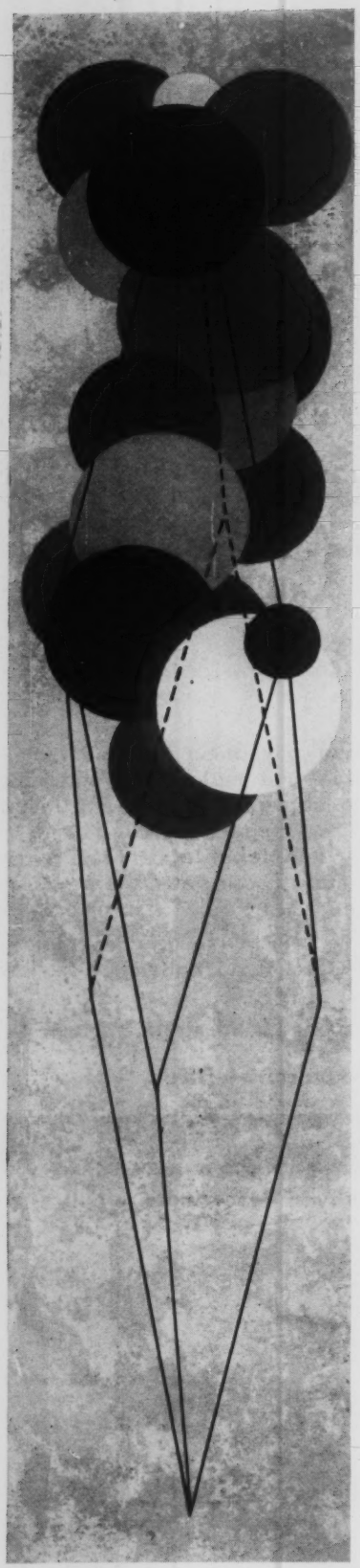
SELENIUM OR SILICON POWER UNITS

MECHANICAL SHAFT SEALS



VIBRATORY FEEDERS

BIN VIBRATORS



Opportunities in

Engineering Analysis

at Atomics International

A fast-growing backlog of major projects is creating future-assured openings for qualified nuclear scientists and engineers at Atomics International headquarters in the suburban San Fernando Valley near Los Angeles. AI is now developing a Sodium Reactor power station for Consumers Public Power District of Nebraska and an advanced type of power reactor for a group of fifteen utility companies in the Southwest. Overseas, five AI research reactors are in operation or under construction—and AI's Organic Moderated Reactor is one of the three power reactor concepts the Atomic Energy Commission has approved for export to Euratom.

Here are some typical current openings:

Reactor Engineering. Analysis and design of over-all power reactor systems and components. Prefer power reactor background in engineering design and analysis. Experience in reactor safeguard analysis also valuable.

Core Analysis. Complete nuclear analysis to include criticality, flux distribution, and reactivity requirements. Fuel cycle economics and optimization.

Shielding. Analysis and design of biological and thermal shielding of large stationary power plants. Advanced studies and methods analysis for compact and mobile power plants.

Heat Transfer and Fluid Flow. Steady state and transient experimentation and analysis. Power optimization studies; free and forced convection flow transients; boiling and two phase flow in water, organic and liquid metal systems.

Structures. Transient and steady state stress analysis of reactor components subjected to mechanical loads, thermal cycling, and thermal shock. Advanced analytical studies in thermal stress fatigue, elastic and inelastic behavior of plates and shells, structural dynamics, and electronic analog and digital computer application.

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

121 FLUID POWER EQUIPMENT

Oilgear Co.—Variable delivery, constant delivery and automatic feed pumps; constant and variable speed transmissions; hydraulic cylinders; servo components; and valves and accessories are among the fluid power equipment described in Bulletin 10051-G. Performance data and specifications are listed.

122 DIAPHRAGM VALVES

Grinnell Co.—An 8-page catalog describes diaphragm valves offering streamlined fluid passage, flow control, leak-tight closure. Isolation of working parts from fluid stream is said to prevent product contamination and corrosion of operating mechanism. Flexibility of assembly and wide choice of materials for bodies, body linings and diaphragms are described.

123 MILLING, GRINDING MACHINES

Cincinnati Milling Machine Co.—Illustrated catalog of 72 pages describes and gives specifications on the firm's line of machine tools for milling grinding, broaching, cutter and tool grinding, and special machine tools. Machines for selective hardening and metal forming are covered and information about the firm's grinding wheels and cutting fluid is given.

124 PRESSURE VESSELS

Koven Fabricators, Inc., Div. of L. O. Koven & Brother, Inc.—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors, tanks, standpipes, piping, stacks.

125 CONSTANT TEMPERATURE PUMPS

Dean Brothers Pumps Inc.—Circular 195 describes new line of standard constant temperature pumps, Types CT-C and CT-R, for maintaining process temperatures when pumping of liquids which congeal, solidify or crystallize with loss of heat. Sectional views illustrate two methods of applying heat to pump: tracing and jacketing.

126 MAGNETIC FLOW METERS

Foxboro Co.—Bulletin 20–14C describes two new magnetic flow meters for different flows. Developed for 1/10 and 3/10-in. lines, they measure full scale flow rates as low as 0.1 gpm, and are said to be useful in ratio flow control and pilot plant applications. Bulletin includes specifications and instrument data.

127 COMBUSTION ANALYZER

Bailey Meter Co.—Instantaneous analysis of exit gases from all types of boiler and industrial furnaces is said to be accomplished by portable Heat Prover combustion analyzer described in Product Specification E65-5. Illustrated in catalytic combustion principle by which per cent by volume of oxygen and combustibles present in a gas sample measured and indicated.

128 REPRODUCTION MATERIALS

Eastman Kodak Co.—All materials available for reproduction of drawings and documents described in a booklet. A selection chart which matches originals to be reproduced with the recommended materials is included.

129 SCREW THREAD STANDARD

O-Vee Gauge Co.—"Screw Thread Standard H.28" has been revised and reprinted and issued Sept. 1957. New gaging requirements are discussed and described in a brochure, illustrated by diagrams.

130 FLEXIBLE, BALL, SWIVEL, SWING, AND ROTARY JOINTS

Barco Mfg. Co.—A group of catalogs cover joints for piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Complete range of sizes. Catalogs No. 215B "Flexible Ball Joints"; No. 265C "Rotary Swivel Joints"; No. 400A "Barco Swing Joints"; No. 310A" Revolving Joints" and No. 269 "High Pressure, Hydraulic Swivel Joints."

131 PNEUMATIC CONVEYING SYSTEM

Spencer Turbine Co.—Bulletin No. 143-B describes stationary and portable pneumatic conveying systems. Systems cover a capacity range from 1/4 through 10 tons per hour; vacuum producers from 5 through 75 hp, and hose or pipe sizes from 2 through 7 in. Conveying under both pressure and vacuum is covered, and applications are illustrated. Specific information is provided on size of unit, rate of conveying, and type and weight of material in each case.

132 BRONZE BEARINGS

Johnson Bronze Co.—A catalog lists and illustrates more than 900 sizes cast bronze bearings, 400 sizes of bronze bars, cored and solid, graphited bronze, powdered bronze in straight, flanged and self-aligning bearings, bearing babbitt.

133 AUTOMATIC LIQUID LEVEL GAGES

Liquidometer Corp.—Bulletin 463A describes 100 per cent automatic remote reading tank gages. Information on direct reading gages at tank and hydrostatic type remote reading gages.

134 STEEL VALVES

Edward Valves, Inc.—Catalog 14 describes cast and forged steel valves for power, petroleum, chemical, marine, and industrial applications. Data includes ASA dimensions, ASA pressure-temperature ratings, and ASTM basic materials specifications, as well as curves and formulas for correlating valve size and pressure drop.

135 OIL AND GAS BURNERS

Engineer Co.—Bulletin OB-63 illustrates different types and sizes of gas and oil burners and includes engineering data and specifications for pumping and heating sets for all types of liquid fuels.

Definitions of Occupational Specialties in Engineering

This book contains comprehensive data related to all activities and specializations in engineering including specific knowledge and duties, responsibilities and related techniques necessary for successful performance in each field.

The ten activity fields defined are research, design, development, testing, procurement, production, construction, operation, administration, and teaching.

Major engineering fields of specialization defined include aeronautical, automotive, ceramic, chemical, civil, electric and electronics, guided missiles, management, marine, materials, mechanical, metallurgical, mining, naval, nuclear reactor, ordnance and armament, petroleum and fuels and power plant engineering. Other engineering fields defined are: packaging, photogrammetry, agriculture, geology, and geophysics.

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LATEST INDUSTRIAL LITERATURE

136 MAINTENANCE IDEAS

Kano Laboratories—An alphabetical list of ideas gathered from the correspondence of industrial customers deals with problems in lubrication, stuck together metal parts, difficult metal cleaning, and lubrication of air driven tools.

137 WELDING FITTINGS, FLANGES

Babcock & Wilcox Co. Tubular Products Div.—Bulletin FB 78 is a guide to the selection of carbon steel, alloy, and stainless steel welding fittings for pressure uses. It covers material selection, specifications and analyses, effects of alloying elements, mechanical properties, arc welding procedures, general catalog information.

138 POLY-V DRIVE

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M141 illustrates and describes the firm's Poly-V drive, a power transmission system that uses only two cross sections instead of five standard V-belts. The unit is said to eliminate problems of matching belts because it is a single unit across the full width of sheave.

139 DEEP DRAWN SHELLS

Pressed Steel Tank Co.—A bulletin summarizes basic applications and economies possible using seamless cupped and deep drawn ferrous and nonferrous shells. Included is information on head shapes and types of open ends available, practical diameter to length ratios, wall thicknesses.

140 O-RINGS

National Seal Div., Federal-Mogul-Bower Bearings, Inc.—This National O-ring catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-rings and local National Seal Division offices.

141 LIQUID CHILLERS

Frick Co.—Packaged liquid chillers, built in sizes from 20 to 180 tons of refrigeration and suitable for chilling water, brine, and other liquids to temperatures far below zero if required, are described in Bulletins 802 and 804.

142 OPTICAL PARTS

Bausch & Lomb Optical Co.—A 16-page catalog of optical parts contains information on ground glass, heat absorbing glass, retardation plates, and the firm's precision glass engraving and optical coating services. A new price list detailing up-to-date individual part prices, discount procedures is included. Catalog L-117.

143 MECHANICAL DRIVE STEAM TURBINE

Murray Iron Works Co.—Six-page brochure describes Type "U" steam turbine for use in industrial plants, and various special applications. The unique design affords horizontally split case above shaft centerline thus providing greater nozzle capacity.

144 AERATORS FOR BULK STORAGE

Bin-Dicator Co.—Catalog describes and illustrates Bin-Flo, nonclogging air pads which use small volume low pressure air to restore flow characteristics to ground materials in storage. Dimensional drawings, mounting details, typical applications, wiring diagrams, list of users.

145 ALLOY STEELS

Copperweld Steel Co.—A 16-page bulletin covers lead treated steels. Case histories of components made of the material are included, along with data on characteristics and mechanical properties of various leaded alloys.

146 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

147 SECTIONAL CONVEYOR

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 458 lists comprehensive technical data, pre-engineered features and an exploded illustration of the firm's new sectional belt conveyor.

148 COPPER DRAINAGE TUBE

Chase Brass & Copper Co.—Publication G-23, 30 pages, tells the story of the economy of copper tube and solder-joint fittings for soil, waste, and vent lines, gives roughing-in dimensions for drainage fittings.

149 VALVE COMPARISON CHART

Ohio Injector Co.—Form 194R2 covers latest editions of new valve designs in the entire valve industry. Also listed is a valve trim comparison table.

150 GEARMOTORS

Western Gear Corp.—Catalog 5806 gives information and integral and all-motor types of straight-line gear-motors. Standard units are available to 50 hp, double and triple reduction.

151 AIR CLEANING EQUIPMENT

Green Fuel Economizer Co., Fan Div.—The company offers three bulletins covering: (1) Aerodyne industrial dust collectors; (2) Aerodyne packaged dust collectors; (3) Econ-o-Roll air filters.

152 TANKS, VESSELS

Graver Tank & Mfg. Co.—Case histories of custom-built tanks and vessels for many different uses are described in the "Echo." Installations in petroleum, chemical and municipal fields are covered. Also steel plate, stainless and aluminum construction.

153 HEAT AND POWER REFRACTORIES

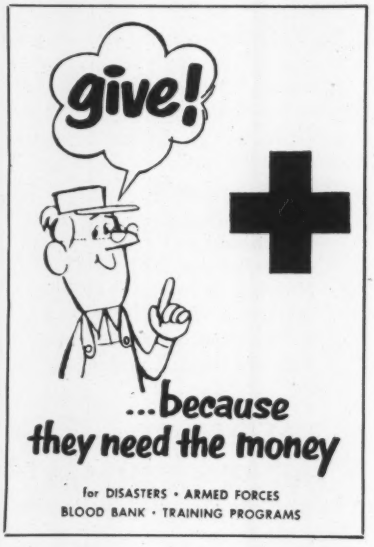
Norton Co.—Thirty-two page brochure compiled for the benefit of boiler operators, setters, and engineers—to aid them in solving refractory problems and to help them obtain greater efficiency from their boilers. Also included is a temperature conversion chart, "Crystolon" brick specification tables and a quick-figuring efficiency chart for boilers.

154 TUBE EXPANDERS

Gustav Wiedeke Co.—Catalog 81 contains specifications on the firm's line of tube expanders and cutters. Included are tables of sizes, ordering information and a list of domestic and foreign distributor locations.

155 LOCKING RING

Rosan, Inc.—Literature describes the firm's positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials. No oversizes are required for replacements, the firm states.



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156 PROCESS INSTRUMENTATION

Fischer & Porter Co.—A 52-page catalog describes the company's products available for immediate shipment. Included are prices. It covers indicating, recording, controlling and transmitting instruments for flow, pressure, density and temperature.

157 V-BELT DRIVES

Dodge Mfg. Corp.—Bulletin A-695, 44 pages, describes a new line of V-belt drives that are smaller, weigh less, and require less space than conventional drives. Photographs and engineering drawings explain construction features, tables of pre-engineered drives, horsepower capacities, belt speeds are included.

158 STEAM GENERATORS

Foster Wheeler Corp.—Bulletin B-56-5 gives drawings and technical data on steam generators in 60 installations. Also included is data on accessory equipment, reheaters, and superheaters.

159 MARKING EQUIPMENT

Jas. H. Matthews & Co.—Four supplements to catalog 146 include 21 pages describing hand marking stamps and tools; 16 pages describing steel marking dies; 19 pages describing marking machines; 17 pages describing identification checks, badges, tags.

160 VIBRATING GRATE STOKER

American Engineering Co.—Literature describes a water cooled vibrating grate stoker in sizes from 25,000 to 150,000 lb of steam per hour. The unit does not require a dust collector and is said to burn low grade coals with efficiency or can be adapted for burning gas or oil in combination with coal or singly.

161 METAL GASKETS

Chicago-Wilcox Mfg. Co.—Form 569 illustrates and describes corrugated metal, asbestos-cord-filled, and plain solid self-sealing gaskets. Drawings show installation procedures.

162 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Revised Catalog E on electrically operated valves includes standard solenoid valves with improved features. Solenoid trip valves are not available with explosion proof solenoid enclosures. New additions are free handle solenoid trip valves, motor operated valve and epichron control switches.

163 AVIATION PRODUCTS

Aluminum Co. of America—A 16-page report covers recent accomplishments in research and development of improved products, construction of new facilities and increased production efficiency to solve aircraft industry problems of production economy and weight control in aluminum components.

164 DEAERATION

Cochrane Corp.—Publication No. 4650 explains in capsule form the fundamentals of deaeration and why it is necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

165 MOTOR CONTROL, ACCESSORIES

Allen-Bradley Co.—A 48-page condensed price catalog illustrates, describes, and gives prices of the most frequently used manual and automatic, full voltage and reduced voltage motor starters. It also lists a wide range of relays, contactors, push buttons, limit switches, and other components necessary for a complete control system.

166 STEEL WIRE

American Chain & Cable Co., Page Steel & Wire Div.—A 16-page catalog, DH-1226, on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional area up to and including No. 3 BWG; flats and rectangles in widths up to $^3/_8$ in., the ratio of width of thickness not exceeding 6 to 1.

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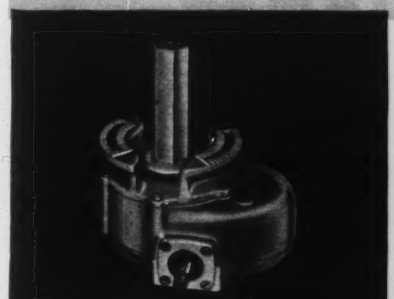
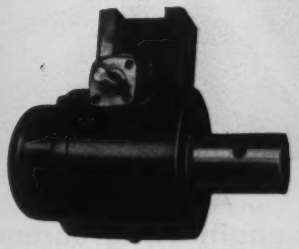
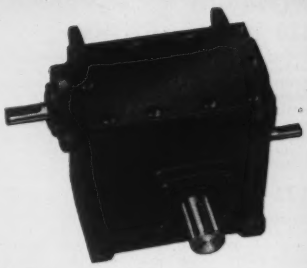


Combination planetary and worm gear reducer for resetting circuit breakers in electrical power stations.



Heavy duty, hand-operated reducer with overload clutch used in automotive engine machining plants.



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LATEST INDUSTRIAL LITERATURE

167 INDUSTRIAL COMPRESSOR

Joy Mfg. Co.—Bulletin describes Wn-224 heavy-duty, four-cylinder industrial compressor, the largest package-type compressor available. Detailed cross-section drawing and complete specification and dimension chart provide description of the unit which has a power range from 350 to 1250 hp and pressures from 85 to 125 psig.

168 VIBRATING SCREEN BEARINGS

SKF Industries, Inc.—Bulletin No. 466 announces and describes a new spherical roller bearing designed to absorb the heavy loads, high speeds, and eccentric motion of vibrating screens while meeting rigid lubrication requirements. Its cage is made of centrifugally cast bronze, having axially drilled and reamed pockets of a shape closely conforming to that of the rollers. Compared with the standard spherical bearing, it has 37 per cent more load carrying capacity, and normal fatigue life is extended 2.85 times.

169 INDUSTRIAL COOLING TOWERS

Marley Co.—Bulletin CF-59 deals with theory, design, structure, and mechanical equipment of Class 600 double-flow and single-flow cooling towers. Auxiliary equipment designed to facilitate maintenance operations is described.

170 HYDRAULIC MACHINERY

Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14,002 is a comprehensive catalog on hydraulic presses for extrusion, forging, die-forging, deep-drawing, Marforming, bending, upsetting and other metal forming operations. It also describes hydraulic stretch-straightening-detwisting machines, stretch-straightening machines for plate and sheet, and pipe testing and expanding machines.

171 NEEDLE VALVES

Lunkenheimer Co.—A four-page circular, 568, covers bronze and bar-stock steel needle valves for close regulation of steam, air, gas, water, oil, or other fluids. Four pressure classes—rated at 200 lb SP, 400 lb WOG; 250 lb WOG; 400 lb SP, 1200 lb WOG; and 3000 lb WOG, 150 F—are described and mounting dimensions given.

172 MACHINERY LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—A 36-page data book gives information on proper lubrication of all types of machinery. Included is data on improvement of machine operations, reduction of power consumption and lowering of maintenance costs through specialized lubricants.

173 STEAM TRAPS

Armstrong Machine Wks.—An enlarged 48-page manual and steam trap catalog includes open float and thermostatic traps, pipe strainers to 6 in. in steel and semi steel, useful steam pipe sizing tables. Fundamentals of good trapping, trap selection, installation, testing, trouble-shooting, and repair are discussed.

174 GLASS FIBER INSULATION

Johns-Manville—Illustrated brochures outline advantages of both Microlite and Superfine glass fiber insulations, low-density resilient insulating materials with high thermal efficiency and round absorption characteristics. They are described as being resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

175 PURIFIERS, MIST EXTRACTORS

V. D. Anderson Co.—Bulletin 803 itemizes principal applications of purifiers which remove liquid, solid and dust entrainment from gases and vapors. Information on internal, receiver and line type separators, mist extractors and scrubbers is included. Exhaust heads and high pressure purifiers designed to withstand pressures to 15,000 psig are also covered.

176 PIPE HANGER

Bonney Forge & Tool Works.—Literature describes the Hangolet, a new welded pipe hanger attachment which eliminates stress concentration at the pipe and hanger junction. The rigidity between the pipe and eye prevents damage to pipe insulation and resultant moisture damage on either hot or cold lines.

177 PNEUMATIC INSTRUMENTS

Republic Flow Meters Co.—Six specification folios cover null-balance-vector pneumatic instruments for utility and process control systems. Described are controller, pressure transmitter, differential pressure transmitter, temperature transmitter, and ratio relays.

178 MULTI-STAGE COMPRESSORS

Norwalk Co.—Catalog 44 describes features of tandem, multi-stage compressors for air and commercial gases. Pressures up to 25,000 psig.

179 DRAFTING MACHINE

Universal Drafting Machine Corp.—Tracmaster, a drafting machine for large size work which features automatic board tilt, is described. The unit has beam-rails that require no initial alignment or subsequent adjustment for straightness. Engine-divided graduations on each rail divide, in effect, the drawing area into a 10-in. grid pattern.

180 GASKETS METAL RASCHIG RINGS

Metallo Gasket Co.—Bulletin No. 57 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also washers, shims, and metal asbestos valve disks.

181 CYLINDERS

Ledeen Mfg. Co.—A 12-page bulletin illustrates and describes the company's line of cylinders for air, oil, water, gas or steam operation in medium, heavy and super-duty construction. Selection information, ratings and limitations, and rod and head attachments are included.

182 ALL-METAL FLEXIBLE HOSE

Universal Metal Hose Co.—Catalog ID-100B, describes all-metal flexible hose and tubing products. The material is edited for the selection of the proper all-metal flexible hose product for a specific application.

183 POWER TRANSMISSION PRODUCTS

Boston Gear Works—A 576-page, pocket-sized catalog contains information on 7,124 standardized power transmission products. More than 50 pages of engineering data are included.

184 GAGE LABORATORY INSTRUMENTS

Sheffield Corp.—A 20-page booklet illustrates and describes Accutron electronic dimensional inspection instruments. Applications, specifications on electronic height gages, internal and external measuring instruments, comparators are included.

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New Catalogs GUIDE

185 PUMPS AND AIR COMPRESSORS

Worthington Corp.—A 24-page brochure detailing information on Standard industrial pumps and air compressors. Also included is hydraulic data and descriptive material on Worthington steam, rotary, power, centrifugal, regenerative turbine and circulating pumps. Also compressed air data and material on Worthington air compressors.

186 VIBRATING SEPARATORS

Southwestern Engrg. Co.—Catalog describing 18, 30, and 48 in. vibrating screen separators. It presents operating, application, and specification data on screening all types of dry materials and separation of solids from liquids in your industry.

187 GLASS PROTECTED STACKS

A. O. Smith Corp., Process Equipment Div.—Bulletin SS-202A illustrates and describes Permaglas smokestacks which feature glass fused to steel on both the inner and outer walls of the stack. Data is given on installation, cost comparison, the firm's manufacturing facilities.

188 WATER CONDITIONING

Permutit Co. Div., Pfaudler Permutit Inc.—A 12-page bulletin, No. 4433, is a general discussion of the major types of water treating equipment—filters, zeolite softeners, precipitators, chemical feeders, demineralizers. Each equipment type is illustrated and discussed briefly. Water impurities and then general methods of removal are tabulated and typical water-treatment systems for municipalities, utilities, and industries are illustrated.

189 HEAT EXCHANGER TUBES

Aluminum Co. of America—Illustrated catalog contains relevant data on Alcoa aluminum heat exchanger tubes. Covers advantages, fabrication, application in petroleum and petrochemical industries, chemical, steam, atmospheric, air, and gas. Also use of aluminum alloys, fluid flow characteristics, heat transfer characteristics, resistance to corrosion specifications and data with tables. Form 10186.

190 PNEUMATIC CONVEYORS

National Conveyors Co.—Four-page Bulletin P58G describes pneumatic conveyor systems for handling bulk materials such as polyethylene and other types of plastic pellets, lime, alum, glass cullet, fine metal chips and borings, small parts and press scrap.

191 EXPANSION JOINT DESIGN GUIDE

Flexonics Corp.—A 28-page expansion joint design guide, Catalog 182, covers engineering application and selection data. A discussion of the various types of expansion joints on the market, types of pipeline motion solved by expansion joints, expansion joint design considerations, installation instructions, and selection data is included.

192 BOILERS, BURNERS

American-Standard Industrial Div.—Loose-leaf binder with separate sheets for each series of Kewanee boilers and boiler-burner package units available includes cutaway drawings, descriptions, specification data and dimensions, and sample specifications. Residential, firebox, and scotch-type boilers are covered, ranging to 651 hp.

193 FRACTIONAL HP MOTORS

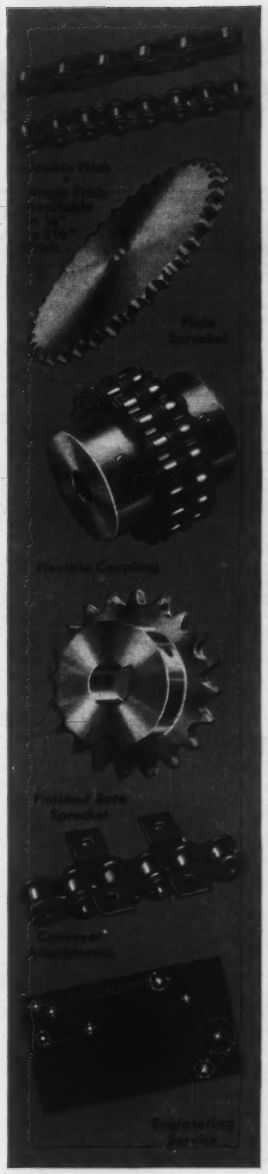
Robbins & Myers, Inc.—A ten-page booklet describes its new line of Model R re-rated fractional horsepower motor available in ratings from $\frac{1}{3}$ to 1 hp in polyphase, capacitor single phase, permanent split capacitor and (in the smaller ranges) split phase types. Totally-enclosed designs.

194 INDUSTRIAL TRACTOR SHOVEL

Materials Handling Div.—Yale & Towne Mfg. Co.—Catalog No. 5255 provides construction data and specifications on Y-18 industrial tractor shovel with 2500-lb carry capacity, 6-ft dumping clearance, fully automatic torque transmission and fast cyclic rate of operation.

195 PRESSURE CODE CHART

Missouri Boiler & Tank Co.—A wall chart provides a quick reference guide to ASME Boiler and Pressure Vessel Code (Section VIII). The chart illustrates some of the types of pressure vessel construction provided for under Section VIII, and furnishes direct references to the Code rules that apply.



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LATEST INDUSTRIAL LITERATURE

196 MAGNETIC DRIVES

Whitney Chain Co.—Data on design, drive features, operating and performance curves, output torque rating-dimensions, selection chart, as well as photographs of installations and applications of magnetic drives are included in the brochure. The new self-contained permanent magnet type magnetic drives are described as fitting new NEMA frame specifications and range in horsepower from 1 to 15.

197 CORRUGATED ROOFING, SIDING

Philip Carey Mfg. Co.—Form 6300 illustrates corrugated asbestos-cement roofing and siding composed of Portland cement and asbestos fibres combined under pressure to form a homogeneous, monolithic sheet. The material is highly resistant to fire, acid and alkali fumes, salt air, rot proof and rodent proof. It never needs painting, but can be painted. Because deep corrugations provide beautiful shadow effects, it is often used for decorative purposes.

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Write for complete information and prices, Bulletin WF-3T.

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198 O-RING CLASSIFICATION

Linear Inc.—A folder introduces a new two-digit series number (11) to indicate all standard industrial sizes, of O-rings. The new ARP 568 uniform dash numbering system is used in conjunction with this series number to provide a single dash number for each of the standard sizes released. This system also adds 38 new sizes.

199 CENTRIFUGAL PUMPS

American-Marsh Pumps, Inc.—Six-page Bulletin 350 describes horizontal split case, single stage, double suction centrifugal pumps. Types HLM and HIM for wide range of capacity and head conditions. Large sectional view explains 18 important features. Specifications, performance data and dimension tables are included.

200 SPREADER STOKER

Detroit Stoker Co.—Catalog No. 860 describes overthrow rotor type spreader stoker for boilers of medium size up to 60,000 lb steam per hour capacity. It burns all grades bituminous and lignite coals and many types of waste or refuse fuels. Power dumping, hand dumping or stationary grades are shown.

201 INDUSTRIAL LOCOMOTIVES

Rogers Bros. Corp.—A bulletin illustrates design and construction of heavy-duty line of diesel-hydraulic industrial locomotives, for all track gages, 5 to 40 tons. Bulletin lists specifications of standard line, and describes special features and accessories available in custombuilt units.

202 STAINLESS STEEL

U. S. Pipe & Foundry Co.—Steel and Tubes Div.—Technical bulletin illustrates and describes how centrifugal castings are made, effect of coarsly columnar cast structures upon mechanical and corrosion resistant properties of austenitic stainless steels; method of preparing test specimens; test results: mechanical properties and corrosion resistant properties.

203 AUTOMATIC VALVES

A. W. Cash Valve Mfg. Corp.—An 82-page catalog describes and illustrates line of pressure reducing and regulating valves, relief valves, back pressure valves, hot water boiler control valves, anti-siphon vacuum valves, and strainers. Contains seven new items not previously included in former catalogs.

204 WORM HELICAL REDUCERS

Jones Machinery Div., Hewitt-Robins, Inc.—A 36-page booklet contains description, drawings, and specification tables on nine standard worm helical reducer sizes with ratios from 25.63 to 1 up to 357.5 to 1 and horsepower ratings from .85 to 175.

205 HUMIDITY CONDITIONING

Surface Combustion Corp.—A booklet outlines the advantages of industrial humidity conditioning to bring about higher production, lower costs, better products, reduced absenteeism. A considerable number of case histories are shown.

206 LIGHT WEIGHT WELDING FITTINGS

Tube Turns—Bulletin TT942 gives specifications for carbon steel light weight welding fittings from 1 through 24 in. Its economies are described as lower material cost, labor saving, and increased efficiency.

207 CONVEYOR BELTING

Manhattan Rubber Div., Raybestos-Manhattan Inc.—A 12-page brochure, No. M302, covers new conveyor belting. Drawings are used to describe the compensation and other features. Pages are arranged to represent an actual cross-section of the belt. It is claimed no breaker fabric is required with this belt, which means more thickness of the cover is utilized.

208 OIL, GREASE SEALS

Federal-Mogul-Bower Bearings Inc.—Catalog 58 gives engineering, selection, and application data on oil and grease seals. The 93-page booklet illustrates the firm's National Seal Division manufacturing facilities and gives information on the various materials used in the seals.

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209 DUST FILTERS

W. W. Sly Mfg. Co.—A 36-page Bulletin 104 describes dust filters and gives engineering information on dust control systems. Operating principles of the firm's Dynaclone are described, and dust filter system specifications and hopper and support data are included.

210 STANDARD MOTORS

Sterling Electric Motors, Inc.—A 12-page colored brochure describes the firm's line of standard electric motors. The bulletin illustrates applications and contains selection information. Exclusive design advantages are described.

211 CENTRIFUGAL PUMPS

Nagle Pumps, Inc.—A four-page folder, Selector, gives briefing on the company's line of pumps for abusive applications. Horizontal shaft and vertical shaft pumps are shown, the latter designed to reduce stuffing box and bearing troubles.

212 EXPANSION JOINTS, PIPING DESIGN

Marquette Coppersmithing Co.—Semi-technical, short report covers service history, test results, manufacturing procedures related to Omega expansion joints and their application to power and process piping systems.

213 HONING EQUIPMENT

Micromatic Hone Corp.—A 32-page catalog, AR-136, explains Microhoning process, including stock removal and automatic size control. Applications, specifications, work capacities of machines for small, medium range diameters, long stroke vertical machines, horizontal machines, multiple-spindle machines are given. Also described are tools, job services, and other company aids.

214 POWER TRANSMISSION

Ohio Gear Co.—A handbook on power transmission contains engineering charts, tables, and formulas on selection of gears and speed reducers. Dimensions of standard spur, bevel, spiral, helical, worm gears, and steel rack are tabulated.

215 SWIVEL JOINTS

Chiksan Co.—Bulletin 1258 describes new line of swivel joints featuring interchangeability of packing for multiple services. They are recommended for chemicals in temperature range between −40 and 400 deg at 300 psi internal temperature using Viton A, steam and hot gas. Bulletin gives packing recommendations for specific services, lists dimensions, charts pressure-temperature relationships.

216 COLD STORAGE INSULATION

Zonolite Co.—Catalog details vermiculite applications for cold storage and low temperature insulation.

217 PACKAGE WATER TUBE BOILER

E. Keeler Co.—A 10-page catalog on water tube package boilers contains illustrations and data on a unit available in capacity range of 6000 to 60,000 lb-steam per hour.

218 POWER PIPING DESIGNS

M. W. Kellogg Co.—Eight-page booklet describes the latest computer methods of analyzing power piping designs. It explains how engineers determine whether forces acting on equipment will meet supplier's guarantee requirements; whether stresses at various points are within allowable ASA Code ranges; and whether sufficient clearances are available for unrestrained pipe movements.

219 ROTARY CAR DUMPER

Heyl & Patterson Inc.—Literature describes a new rotary railroad car dumper. The unit is equipped with two clamps holding the car securely, not requiring counterweights. It can be dumped and returned in one minute with a 30-hp drive. Optional equipment is electronic scale in the dumper platen and power operated car retarders.

220 HIGH TEMPERATURE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 128 illustrates Types A, AC, OV, UNI, multistage, centrifugal pumps for high pressure, high temperature heavy duty services. The pumps range in size from 2 to 8 in. with maximum speeds to 6000 rpm, capacities to 2700 gpm, maximum temperatures to 850 F, discharge pressures to 2000 psig, differential heads to 4500 ft.

221 METAL STAMPING

Stamping Div., Rockwell-Standard Corp.—An eight-page booklet describes Bossert's engineering and re-design service, illustrates complete facilities for producing large or small stampings and welded assemblies in any metal or alloy. Also illustrated are intricate stampings produced for a diversified group of metal products.

222 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog Number 858, a 64-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches.

223 TIMING BELT

United States Rubber Co., Mechanical Goods Div.—A set of manuals illustrate and describe, with drive tables, the PowerGrip timing belt. This drive is said to assure tooth-grip precision, and for power transmission its steel cable tension member provides horsepower that ranges from 1/120 to 600 and up, without stretch.

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224 SURGE RELIEF VALVES

Golden-Anderson Valve Specialty Co.—An eight-page bulletin, W-2A, describes cushioned surge relief valves in sizes 1/2 to 36 in. These valves are used to protect water lines against excessive pressures caused by surges in the system. Installation arrangements, parts lists, dimensions and specifications are included, along with technical information on installation and operation. Featured is a chart showing relief valve capacities.

225 SEALED BEARINGS

Stephens-Adamson Mfg. Co., Sealmaster Bearings Div.—Bulletin No. 758 illustrates and describes the firm's Sealmaster bearings. Standard and special units are available. Cutaway photos show such features as zone hardening, locking pin and perimeter dimple, labyrinth seal, ball retainer.

226 AIR CONDITIONING MOTOR PUMPS

Ingersoll-Rand—Form 7473 describes motor pumps of the KRVS-KRVSA line. They range from 1/2 to 7 1/2 hp and are built for air conditioning, refrigeration, and coolant circulation work. The centrifugal units have cast bronze impellers which run directly off short motor-shaft extensions of NEMA frame motors. The eight-page booklet gives performance curves, along with data on dimensions and a work sheet for pump selection.

227 CLEANABLE FILTERS

Cuno Engineering Corp.—Literature covers Auto-Klean and Super Auto-Klean edge-type cleanable filters, and filters for built-in installations, and Micro-Screen filter elements of reinforced screen mesh.

228 INDUSTRIAL POWER TOOLS

Rockwell Mfg. Co., Delta Power Tool Div.—Drill presses, grinders, shapers, planers, jointers, metal and wood cutting lathes, tilting arbor saws, unisaws, band saws, and radial saws are described in an 88-page catalog. Specifications, catalog listings, and descriptions of accessories for all tools are included.

229 CENTRIFUGAL FANS

Ilg Electric Ventilating Co.—Type BC centrifugal fans with airfoil blades, aluminum sides and scroll, in both direct-connected and belted models for ventilating and heating equipment are illustrated and described in eight-page Bulletin S317. Performance, dimensions and capacities are given for each type with detailed drawings.

230 SPRING MATERIALS

Hunter Spring Co.—A 12-page booklet discusses pricing, quoting, tolerances, tangling, packaging, spring materials with cost comparisons, quality reporting.

231 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hour.

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LATEST INDUSTRIAL LITERATURE

232 CENTER GUIDED CHECK VALVE

Miller Valve Co. Inc.—An eight-page bulletin illustrates and describes the Streamflow center guided check valve, said to be silent and shock-proof, and which can be installed vertically or horizontally. Specifications and dimensions are tabled.

233 SQUIRREL CAGE MOTORS

Sterling Electric Motors, Inc.—A 64-page catalog illustrates a-c squirrel cage motors, speed reducers, and variable speed drives. Featured additions are right angle gear motors, right angle variable speed drives, and an expanded range of variable speed drives from 4660 to 1.3 rpm in variations from 2:1 and 10:1.

234 HIGH TEMPERATURE WATER PUMPS

Dean Brothers Pumps Inc.—Circular 214 describes the firm's line of standard centrifugal pumps for high temperature water systems used for large volume space heating and for industrial process heating. Pumps for boiler and system circulating and for boiler water make-up are illustrated. Pump data and stuffing box sealing information are also included.

235 CONVEYOR SYSTEMS

Fuller Co.—Bulletin G-3B, 12 pages, pictures and describes pneumatic conveying systems for handling dry, pulverized and granular materials. Diagrams show how systems work, and rotary compressors, vacuum pumps, horizontal grate coolers, Homboldt preheater, Sutorbilt positive pressure blowers, gas pumps, Lehigh induced draft fans, dynamic hot gas washers are covered.

236 WATER SOFTENERS

Permutit Co. Div., Pfaudler Permutit Inc.—Bulletin 2386-B describes trouble caused by using hard water. Equipment specifications, operating characteristics, data on ion exchange resins and typical installation photographs are included.

237 WORM GEAR JACKS

Duff-Norton Co.—Eight-page bulletin, No. AD-66, describes how two or more jacks can be tied together in a jacking arrangement by means of couplings, shafting, and mitre gears boxes. All jacks will raise and lower in unison and arrangements can be motor driven. Jack capacities range from two to one hundred tons. Specifications and dimensions drawings are included.

238 AIR CONDITIONING, REFRIGERATION

Curtis Mfg. Co.—A four-page brochure covers entire line of air conditioning and refrigeration equipment. It illustrates and gives specifications on packaged air conditioners 3 to 50 tons, air cooled air conditioners 3 to 7½ tons, packaged liquid chillers 7½ to 100 tons, condensing units ¼ to 100 hp, cooling towers, evaporative condensers, air cooled condensers, air handling units.

239 PROCESSING EQUIPMENT

Patterson-Kelley Co.—Bulletin 16 contains product description and specifications on the firm's line of blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, and process heat exchangers. The bulletin also describes the organization and operation of the company's Pre-Test laboratory which, in testing customer formulations, helps determine proper blending equipment and correct blending procedures.

240 HYDRAULIC FLUIDS

Vickers Inc.—A 24 page catalog, No. 1300SA, describes the selection, operation, and maintenance of hydraulic fluids for industrial machinery. It contains information on general qualities, lubricity, viscosity, viscosity index, oxidation resistance, neutralization number, rust and corrosion, demulsibility, foam, cavitation, additives and fire-resistant fluid selection.

241 SHAFT SEALS

Syntron Co.—Two bulletins are offered on shaft seals. One gives data and specifications on mechanical shaft seals for rotating shafts on pumps, turbines, compressors, engines, and mixers. The other covers face-type marine shaft seals which feature a split, inflatable sealing ring that permits worn seal parts replacements without dry-docking large vessels.

242 BLOWERS, EXHAUSTERS

M-D Blowers, Inc., Subsidiary of Miehle-Goss-Dexter—Six-page folder on 3-lobe rotary positive industrial blowers and exhausters covers advantages over conventional 2-lobe blowers in pressure range, size, weight, cost, and service. Operating data, capacity curves, and typical applications, including use in pneumatic conveying, are given for 24 production models.

243 CARBON SPECIALTIES

Morganite, Inc.—A 12-page bulletin illustrates, describes and gives design data on carbon specialties in such applications as self-lubricating bearings, valves, slides, seal noses, gland rings, piston rings and vanes.

244 DOUBLE SUCTION PUMPS

Warren Pumps, Inc.—Bulletin 251 covers Type DMB and DB ball bearing, horizontal split case, double suction centrifugal pumps for general water service. The bulletin includes specifications, sectional view, selection table, and outline dimensions.

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Air hammers, drills, sand blasts may be working... but are they working at peak efficiency? With the right Curtis compressor on the job, you can be sure of an adequate and dependable supply of compressed air at the proper pressure.

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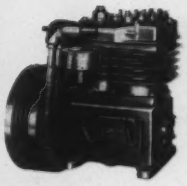

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245 TIME ORGANIZER

Kano Laboratories—Literature describes a time organizer system in which items are listed on numbered lines and checked out as completed. The system includes a three-year calendar, annual and monthly check charts and detailed suggestions for use.

246 ELECTRIC HEATERS

Edwin L. Wiegand Co.—Catalog 975-B illustrates and describes electric blower-type portable unit heaters, wall and ceiling mounted unit heaters, forced air heaters for large areas, radiant and convection comfort heaters, thermostats and contactors for commercial and industrial use.

247 UPVC FITTINGS, FLANGES, VALVES

Tube Turns Plastics, Inc.—Unplasticized polyvinyl chloride pipe fittings, flanges and valves are the subject of Bulletin TTP119. It discusses industrial applications of PVC piping and gives complete specifications for threaded and socket type of fittings and flanges, in both normal and high impact grades.

248 GASKETS

Garlock Packing Co.—Bulletin AD-104 describes the firm's Guardian spiral wound metal gaskets. The bulletin details features and design factors of the metal gaskets as well as the types available for specific applications.

249 BRASS MILL TERMS

American Brass Co.—A 24-page illustrated lexicon called "Copper & Copper Alloy Metalexicon" untangles complex terminology applied to brass mill products.

250 HYDRAULIC POWER

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 200 illustrates and describes the firm's 2000 psi vane pumps designed for hydraulic power systems. Operating characteristics of the units are shown in tabular form.

251 EXPANSION COMPENSATORS

Flexonics Corp.—Bulletin AIA No. 30C-22 illustrates and describes expansion compensators for steam and hot water lines. Included is data on a high pressure type of 175 psi and a low pressure type to 60 psi.

252 BALL THRUST BEARINGS

Gwilliam Co.—Catalog No. 28 describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

253 DEAERATING HEATERS

Graver Water Conditioning Co.—Bulletin, WC-106A, on tray type deaerating heaters covers principles of deaeration; tray heater operation; standard heater design and applications; accessory equipment, and design and fabrication of tray utility heaters.

254 TOOL STEELS

Crucible Steel Co. of America—Forty-six pages of information concerning tool steels for forging operation, the die casting process and the hot extrusion process. A series of charts detail the tool steel and heat treatments recommended for numerous forging, die casting, and extrusion operations. Also included is a brief trouble shooting guide.

255 SPEED REDUCERS

Stephens-Adamson Mfg. Co.—Catalog 643 covers single and double reduction type speed reducers. Specifications and dimensions are tabled, and installation information is given. A section of the 12-page booklet deals with the firm's materials handling equipment.

256 AUDITORIUM AIR CONDITIONERS

John J. Nesbitt, Inc.—Catalog 22 illustrates and describes AudiCon air conditioner, designed especially for school auditoriums and other large assembly areas where quietness is important. Unit features silencer discharge plenum, plus return air bypass control.

257 GRINDING WHEELS

Norton Co.—A 30-page catalog with net price supplement covers Alundum and Crystolon grinding wheels for all types of operations. It also contains information and prices on abrasives for polishing and Tumblex abrasives for barrel finishing.

258 BOILER SAFETY DEVICES

Reliance Gauge Column Co.—Bulletin 516 is a condensed catalog of water columns, water-level gages and accessories, and liquid-level alarms. It is a key to more complete catalog sections describing this class of equipment is made by Reliance.

259 MATERIALS HANDLING

Conveyor Systems, Inc.—Catalog No. 6 consists of 90 pages of data relative to conveyors and special materials handling equipment for use in all industries.

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A large manufacturing plant formerly discarded approximately 100,000 lbs. of fused welding flux a year from their submerged arc welding process. Now, an American Welding Flux Crusher regranulates the fused welding flux, the fines are separated, and the flux is reused. With new welding flux costing approximately 10¢ per pound, this company makes a saving of $10,000.00 per year.

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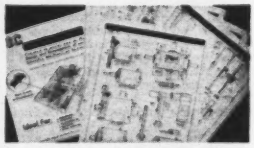

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New Catalogs

260 INDUSTRIAL FASTENERS

Bethlehem Steel Co.—Catalog 436 describes with complete list prices, container quantities, extras, weights, and other data on standard bolts, spikes, rivets, and other industrial fasteners.

261 METAL HOSE

Atlantic Metal Hose Co.—Bulletin 500-A contains descriptions and illustrations of high pressure hose made of heavy bronze or galvanized steel strip, air jacketed hose for diesel exhaust, conveyor hose for ventilating and exhausting. Bulletin 21-A covers flexible stainless steel hose.

262 VARIABLE SPEED DRIVE

Cleveland Worm & Gear Co.—The firm's speed variator, a precision mechanical variable speed drive of 9:1 total range of ratio, is described in an eight-page, illustrated booklet designated K-200. The brochure provides product description and engineering information, including sectional views, dimensions, capacity ratings.

263 RECORDING SYSTEMS

Consolidated Electrodynamics Corp.—Technical bulletins covering DataTape magnetic-tape recording and playback systems furnish descriptions and specifications for airborne and ground-based components and accessories. Ground system is described in Bulletin Nos. 1576, 1608, 1613, and 1615. Airborne components are covered in Bulletin Nos. 1592-5, 1578, and 1607.

264 AIR MOTORS, COMPRESSORS

Gast Mfg. Corp.—Bulletin illustrates original equipment and plant use applications of rotary air motors, air compressors, and vacuum pumps. Diagrams show many ways to put air to work, and photographs give factual details.

265 CLAD STEEL EQUIPMENT

Lukens Steel Co.—A 28-page booklet covers the development, manufacture and properties of clad steels, the types of cladding materials available, design considerations, fabrication techniques and clad steel equipment applications.

266 MISSILE LAUNCHING EQUIPMENT

Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14.004-B shows a revised and supplemented collection of the firm's activities in the field of missile ground handling and launching equipment, including the ship motion simulator for the Navy's ballistic missile program.

267 DIRECT CONNECTED FANS

Robbins & Myers Inc.—A 12-page pamphlet summarizing the design features and component parts of the Propellair fan. Included also are pictorial descriptions of some typical installations. In addition performance data for Propellair axial flow fans in charted. Also described is the Sky-Blast power roof ventilator.

268 GEAR REDUCERS, INCREASERS

Lufkin Foundry & Machine Co.—Catalog G-4 covers engineering and dimensional data on standard lines of slow and medium speed herringbone gear reducers of single and double reduction type and high speed herringbone gear units for speed reducing or speed increasing service. Engineering data on selection of size is given.

269 HEAT ENCLOSURES

M. H. Detrick Co.—A 50-page illustrated booklet "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall construction and their application are shown for various types of units. Engineering graphs and tables are presented. Special booklets on incinerators, forge furnaces, open hearths, and insulation available.

270 CONTROL VALVES

Conoflow Corp.—A 12-page bulletin describes construction and operation of the Series LB control valve. Features, including single-seat construction, extra thick body walls, integral or separable flanges, fully guided plug, and liftout seat ring, are covered. Operation of new Model J valve positioner is discussed.

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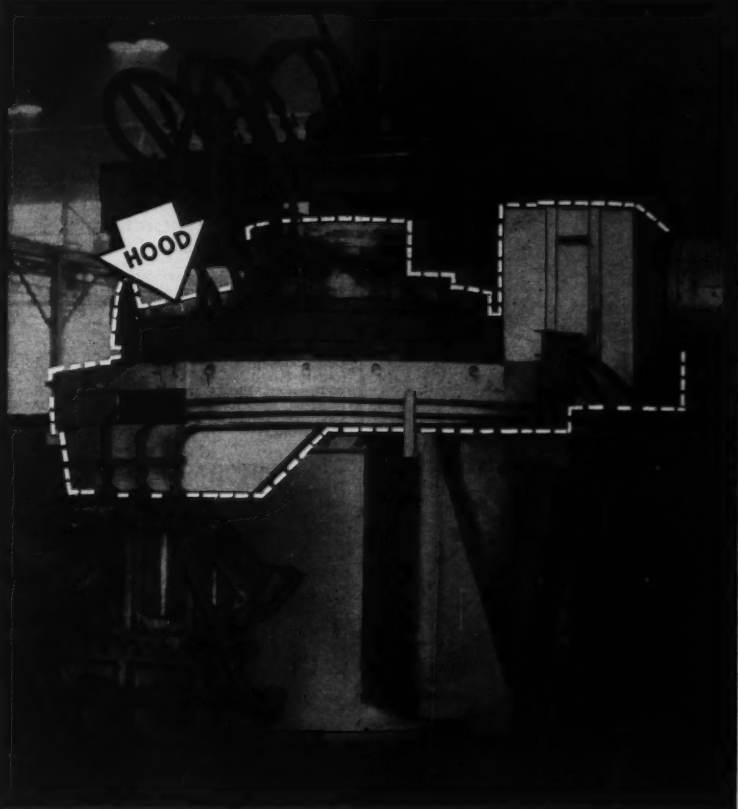

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271 AIR-GRAVITY CONVEYOR

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 58-K illustrates and describes Air-Float conveyor for air-gravity conveying of dry free-flowing materials. Of principal interest to the cement, lime, and chemicals industries, the unit uses an exclusive porous plate for the conveying surface.

272 ALUMINUM PIPE, FITTINGS

Aluminum Co. of America—A 20-page booklet covers process piping, pipelines, portable piping, structural piping applications, fittings and flanges, installation, dimensions and weights of aluminum pipe and fittings. Form 10197.

273 TRANSDUCERS

Consolidated Electrodynamics Corp.—A 16-page folder, No. 1308, on transducers and associated equipment, illustrates and describes vibration pickups, velocity pickups, torsiographs, pressure pickups, dynamic pressure pickups, galvanometers, and telemetry equipment.

274 DRAFTING ROOM EQUIPMENT

Hamilton Mfg. Co.—Catalog No. 15 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, and information about the "L" table and shallow-drawer unit with tracing lifter plus new Hamilton-Pack interlock files.

275 SURFACE CONDENSERS

Worthington Corp.—Bulletin W-200-B3A shows applications of surface condensers for steam power stations, industrial processes, marine and water works service.

276 BIN LEVEL CONTROLS

Bin-Dicator Co.—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator unit. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users are included.

277 FLOW CONTROL VALVE

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 143 illustrates and describes the firm's multi-range flow control valve in ¼, ⅜, and ¾ in. sizes. The unit is shown in a cutaway drawing and applications for machine tools, automation, and petroleum equipment are illustrated.

278 PROCESSING SERVICE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 135 describes new SVE centerline mounted single stage centrifugal pump developed for petroleum, petro-chemical, chemical and other processing services. Detailed dimensions chart, parts interchangeability chart and pump size selection chart are included.

279 OPTICAL TOOLING

Charles Bruning Co.—A 20-page illustrated booklet, explaining the theory, principles, and practice of the new technique of optical tooling. The booklet shows how optical tooling provides tolerances of .003 in. in 100 ft. It is claimed to offer easier construction, assembly, inspection, and unsurpassed dimensional control in erecting jigs, fixtures, and assembly structures.

280 AIR POWER COMPRESSORS

Ingersoll Rand.—Form 3266 describes features of air power compressors. Included are reciprocating and centrifugal, stationary and portable units from 1 to 6000 hp. The pocket-size booklet also provides a selection chart showing which compressors are available for various capacities.

281 FIRE-RESISTANT FLUIDS

Shell Oil Co.—A technical bulletin gives detailed information on synthetic fire-resistant hydraulic fluids. Data covers applications, operating advantages, procedures for changing systems and packings, gaskets, paints, and seals.

282 PRECISION MEASUREMENT

Sheffield Corp.—A 22-page brochure describes the precision measurement and inspection services of the firm's Eli Whitney metrology laboratory. Services include calibration and certification of gage blocks, roundness determination, hardness testing, surface finish analysis, thread and plug gage calibration.

283 OIL/GAS BURNERS

Wickes Boiler Co.—Bulletin 58-1 provides information on oil/gas burners for shop-assembled and field erected boilers suitable for automatic combustion and safety controls. Single or multiple burner arrangements are shown. The burners are of steam, or air atomizing type for oil, center ring type for gas.

284 REFRACTORIES

Carborundum Co.—Bi-monthly bulletins about refractories, their properties, uses and recent developments, are available. Subjects covered include muffled constructions, brickwork construction, research and development, a new silicon carbide refractory, wear resistance refractories, hot strength, heat resistance of refractories, thermal-shock resistance, chemical resistance, and stability.

285 CAST NICKEL ALLOYS

International Nickel Co.—A 28-page booklet presents capsule reviews of all major nickel-alloyed cast materials. Tables of compositions and properties cover cast low alloy steels, cast stainless steels, ductile irons, alloyed irons, nonferrous cast alloys, and cast high nickel alloys.

286 BOILER SHOT CLEANING

Diamond Power Specialty Corp.—Bulletin No. 2145 describes a new shot cleaning system for removing soot and ash deposits from horizontal super-heaters, economizers, and reheaters, and internal surfaces of tubular air heaters. Steel shot is dropped by distributors over the area to be cleaned. As it bounces back and forth, it removes deposits in small particles.

287 FOUR-CYCLE V-ENGINES

Nordberg Mfg. Co.—Four-cycle V-type engines are described in an 18-page bulletin. Examples are shown of the significant advancements in diesel engine performance for V-type engines that are supercharged, supercharged and intercooled, and Supairthermal.

288 THREADED INSERTS

Rosan Inc.—Literature describes an externally and internally threaded insert, trademarked Inserto that is external thread locking and through-broached hexagonally on the internal threads to accommodate a hex-bar used to install the parts. The inserts are available in case hardened steel in sizes No. 4 through ⅜ in.

289 WATER COLUMNS, GAGES

Ernst Water Column & Gage Co.—Bulletin 8-13-58 illustrates and gives specifications of bronze gages, flow indicators, water columns, steel gages and valves, gage glasses and gaskets.

290 VALVELESS FILTER

Permutit Co. Div., Pfaudler Permutit Inc.—Bulletin No. 4351 describes the company's automatic gravity sand filter for municipal or industrial water treatment. The unit uses no valves, pumps, or flow controllers, and is said to cost less than conventional manual filters, reduce costs of installation, operation, maintenance and expansion, and produce uniform high-quality effluent. Sizes up to 400 gpm are available.

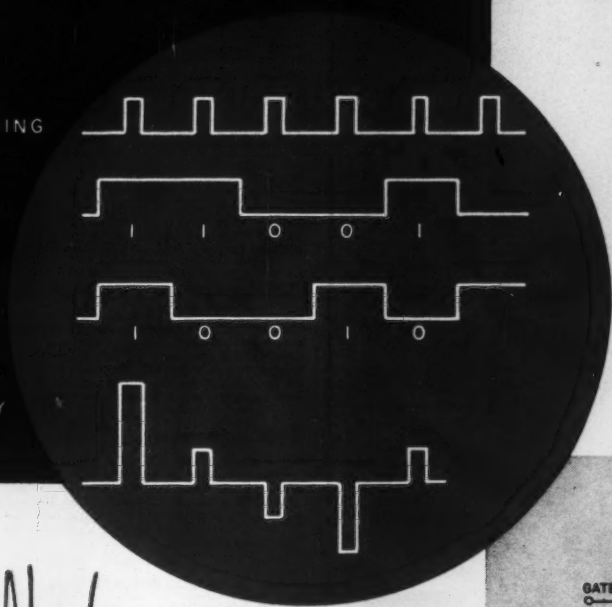
291 ASBESTOS-CEMENT BOARD

Philip Carey Mfg. Co.—Form 6285 describes asbestos-cement board for exterior walls, partitions, linings, utility structures. The material is not affected by most acids, alkalis, fumes, heat, cold, weather, salt air. It is vermin and rodent proof, will not rot, rust or corrode, and needs no paint or protective coating. It can be painted for decorative purposes. Suitable for continuous temperatures up to 600 F.

292 VARIABLE SPEED DRIVES

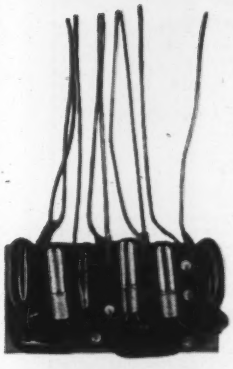
Sterling Electric Motors, Inc.—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included.

PULSE CODE MODULATION

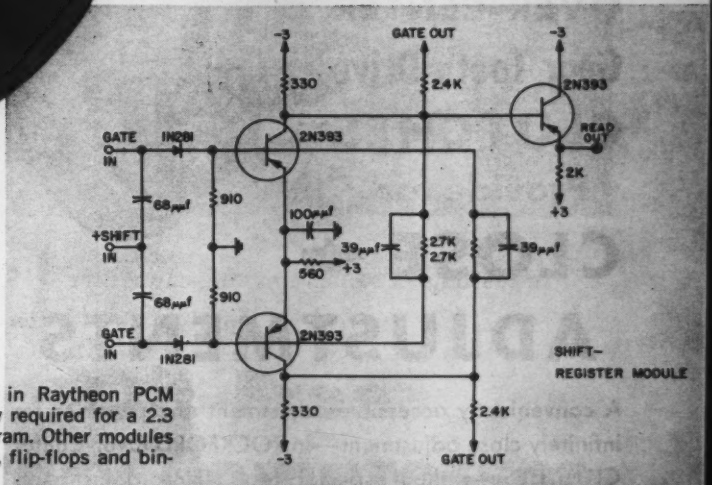


PCM is a new method of coding voice and analog information into digital form. It provides a completely digitalized message by time-division multiplexing of voice circuits. Adaptation of the technique offers advantages in signal-to-noise characteristics, signal regeneration, message security and equipment reliability not usually achieved with conventional techniques.

A 96-voice channel, fully transistorized PCM equipment for cable and radio transmission meeting rugged military requirements is now being developed by the Communications Department of Raytheon's Government Equipment Division. In this system a sampling frequency of 8,000 cycles is used. Each sample is coded in six-bit binary form, at a bit frequency of 4.6 mc. Many new circuit techniques, closely allied to high-speed data processing and computer systems are being developed for this equipment.



THE QUATERNARY WAVE combines information from trains 1 and 2, and the timing pulse regulates the width and position of the quaternary output wave. Thus, twice as much information is passed through the same bandwidth as is required for one train.



TYPICAL MOLDED MODULE used in Raytheon PCM equipment comprises logic circuitry required for a 2.3 mc shift register shown in the diagram. Other modules are used for repetitive and-or gates, flip-flops and binary-storage elements.

NEW OPPORTUNITIES WITH A FUTURE

Your background in design, development, production or manufacturing of radar, sonar, infrared, communication or countermeasure equipment may qualify you for an engineering future with Raytheon. Please write to Donald H. Sweet, Professional Personnel, Raytheon Manufacturing Company, Government Equipment Division, Wayland, Massachusetts.

Engineering Laboratories: *Wayland, Maynard, Mass.; Santa Barbara, Calif.* • Manufacturing Facilities: *Waltham, North Dighton, Mass.*

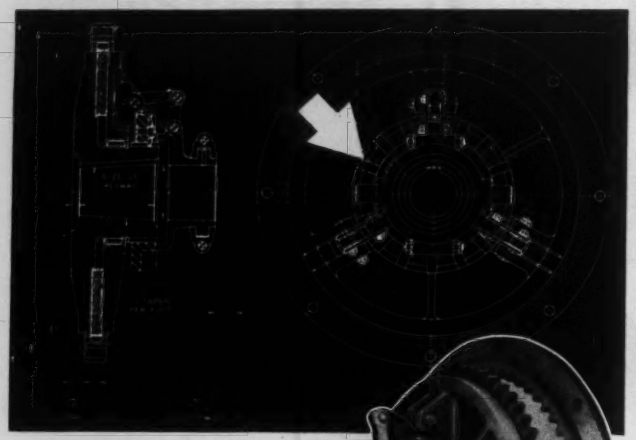
RAYTHEON

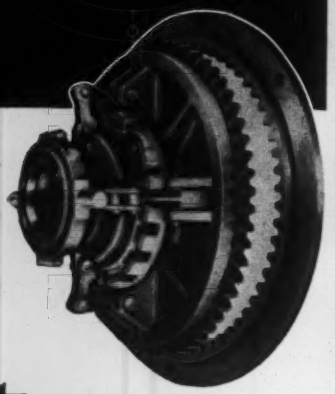
Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION

LAND — SEA — AEROSPACE

ROCKFORD





OVER-CENTER Gear Tooth Drive CLUTCHES Provide for CLOSE ← ADJUSTMENTS

A conveniently accessible adjustment ring provides for infinitely close adjustment—in ROCKFORD Over-Center CLUTCHES—without special tools. Fine adjustments can be made, and automatically maintained, without releasing or engaging separate locking devices which formerly limited adjustments to the spacing of notches or holes. This is but one of several exclusive features of ROCKFORD Over-Center CLUTCHES.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

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Small Spring Loaded

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Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

ROCKFORD B-W BORG-WARNER

CLUTCHES

YOUR *New Catalogs* GUIDE

293 REPRODUCTION MATERIALS

Eastman Kodak Co.—A booklet outlines ways in which Kodagraph reproduction materials can provide short cuts and savings in reproduction departments, drafting rooms, and in the field. The 12-page booklet diagrams seven applications for the materials.

294 STREAMLINED BAFFLES

Engineer Co.—Bulletin BW-54 shows the design and describes the construction of streamlined baffles for many types of water tube boilers for various furnace designs and methods of firing.

295 HOT-DIP GALVANIZING

American Hot-Dip Galvanizers Assn.—A 16-page booklet outlines rust prevention in industrial and consumer products through the use of the hot-dip galvanizing process. Included are photographs of products made by the method, and illustrations of production and quality control. Chart compares method with other types of rust prevention.

296 DIAZO PROCESS

Charles Bruning Co.—A 12-page booklet, explains the basic principles, features, and applications of the Copyflex diazo reproduction process. Described and illustrated are the types of material available, ways in which the process can be used to cut drafting time and expense, and some of the machines available.

297 STAINLESS PIPE WELDING

Arcos Corp.—How to make the first, or root pass, in welding stainless or alloy pipe, welding from one side only is the subject of an 11-page bulletin. The use of a specially designed consumable insert to produce a sound weld, crevice free, with a flat contour inside the pipe, is described.

298 PRESSURE GAGES

American Chain & Cable Co., Helicoid Gage Div.—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within $^1/_2$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

299 COLD ROLL FORMING

Yoder Co.—An 88-page reference manual on cold roll forming covers operating speeds, tooling, personnel training and operating techniques, surface finish, uniformity, forming of pre-coated stock, selecting proper equipment.

300 STORAGE TANKS

W. E. Caldwell Co.—A revised 48-page catalog, No. 68, contains technical data, illustrations and price information covering metal and wood tanks with mechanical equipment and other accessories. Included are elevated and ground storage tanks, field erected, shop build pressure, vented tanks.

301 STEAM PRESSURE REDUCING VALVE

Leslie Co.—Bulletin No. 582 gives facts on Leslie-Topper, a new concept in steam pressure reducing valve design. The unit has a mechanical piloting device that is entirely out of the path of steam and the bulletin offers comparison capacity regulation data and sizing information.

302 HEAT EXCHANGERS

American-Standard Industrial Div.—Bulletin 1.1K6 describes expanded, redesigned line of standardized, pre-engineered Type BCF exchangers. New features include baffles with flanged lip at tube holes and outer edge for improved thermal characteristics; movable feet; corrosion resistant copper alloy core assembly; and cast iron bonnets. Specifications detail 46 stocked sizes in one, two and four-pass designs.

303 BOILER SAFETY CONTROLS

McDonnell & Miller, Inc.—A 24-page booklet covers safety control problems encountered in the low pressure steam field from small domestic boilers to multiple installations. It shows the right products, correct hook-up, proper wiring.

YOUR

New Catalogs

GUIDE

304 WATER CONDITIONING

General Filter Co.—Bulletin No. 5763-A on Zeolite softening illustrates and describes CR softeners and how to select the proper size when hardness and flow is known. Bulletin No. 5811 on clarification illustrates and describes the five basic Contraflo designs and their application in water and waste treatment plants.

305 THERMOCOUPLE REFERENCE JUNCTION

Pace Engineering Co.—Data sheets describe a precision and a utility series of Thermocouple Reference Junctions of multi-channel temperature measurement systems. A discussion of special circuit features and Thermocouple combinations is included, specification on temperature stability and uniformity among channels.

306 OPTICAL INSTRUMENTS

Bausch & Lomb Optical Co.—A booklet, "Industrial Optical Aids," contains information on an assortment of inexpensive precision optical instruments and suggests ways to use them to gain faster, easier, lower-cost production. Items discussed include magnifiers, microscopes, wide field tubes, macroscopes and comparators. Catalog D 1059.

307 PACKINGS

Johns-Manville—A 12-page brochure, PK-17A, contains a packings selection chart of rod, plunger, and valve stem packings; illustrations and descriptions of precision rings, hydraulic and groove packings, oil seals, metallic and cut gaskets.

308 STRUCTURAL INSULATING PANELS

Philip Carey Mfg. Co.—Form No. 6301 provides data on a rigid, structural material that also insulates walls, roof decks, partitions. It is made by bonding asbestos-cement board to both sides of a specially processed asphalt-treated insulation board. The material is described as lightweight, water-resistant, approximately 60 per cent light reflectivity, won't rust nor rot and needs no preservative treatment or painting.

309 AIR COMPRESSORS

Gardner-Denver Co.—An eight-page bulletin illustrates and describes carbon piston horizontal single-stage air compressors for oil-free air in the processing, chemical and plastic industries.

310 FIRE PUMPS, FITTINGS

Peerless Pump Div., Food Machinery & Chemical Corp.—A 32-page bulletin, No. B-1500, describes, illustrates, and tabulates, with dimensional data, hundreds of models of Underwriters approved horizontal and vertical centrifugal fire pumps, fittings, and drivers for application to commercial and industrial risks. Addendum includes selection charts with data for each model.

311 HEATERS, HEAT EXCHANGERS

Patterson-Kelley Co.—Catalog No. 202 contains 36 pages of product data and application tables for instantaneous hot water heaters and heat exchangers. Data includes dimensions, standard connections, piping arrangements, and diagrammed line drawings of two-, four-, and six-pass instantaneous heaters, plus condensate coolers (or preheaters) and booster heaters constructed in accordance with ASME code requirements.

312 FILTERS, FILTER ELEMENTS

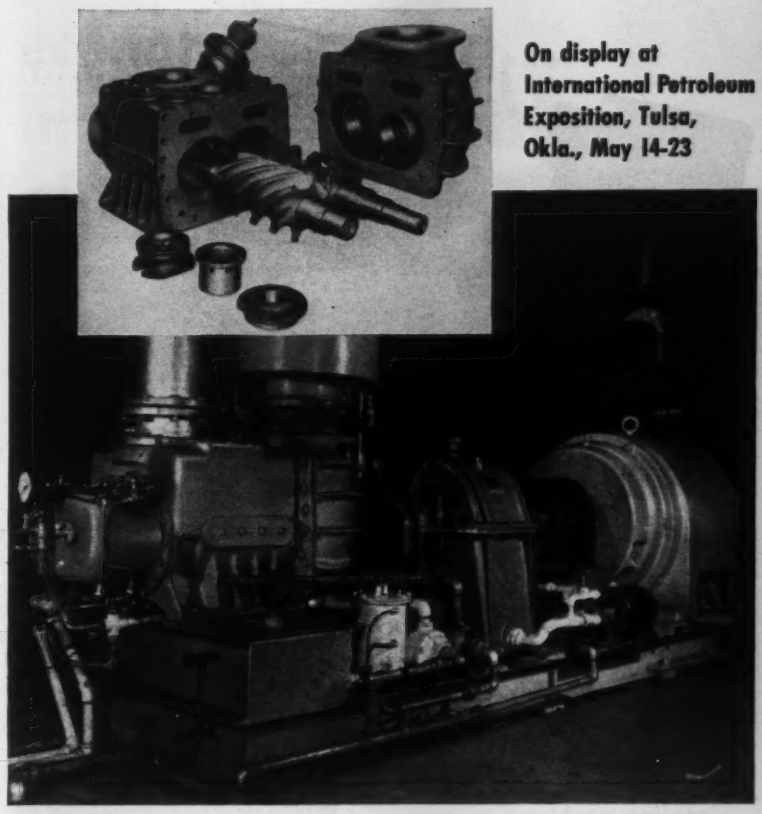
Cuno Engineering Corp.—Catalogs cover Micro-Klean replaceable filter elements, Flo-Klean automatic self-cleaning wire-wound filters, Poro-Klean porous stainless steel media for filtration, Micro-Klean filters for air line service, and Micro-Screen filter elements of reinforced screen mesh.

313 POLYVINYL PRODUCTS

B. F. Goodrich Chemical Co.—A booklet gives properties and illustrates applications of Geon vinyl resins for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings and rigid materials.

314 MOTORS, REDUCERS

Falk Corp.—Revised Bulletin 3100 contains information on all-steel Motoreducers from 1 through 75 hp. Included are new dimensions and motor weights for the rerated NEMA motors. It contains information on selection of horizontal, vertical, or right angle units in either the all-motor or integral design.



On display at International Petroleum Exposition, Tulsa, Okla., May 14-23

NEW *Fairbanks-Morse Positive Displacement Axial-Flow...*

Oil-Free Rotary Compressor

for pressure, vacuum or booster service!

Here is a mechanically-simple, precision-built, high-efficiency compressor that combines the best features of reciprocating and centrifugal designs!

The new Fairbanks-Morse Axial-Flow Rotary Compressor is a two-impeller helical-lobe type machine ...ideal for a wide variety of applications...smooth in performance, adaptable to any power source. Unit weights and space requirements are impressively low.

Standard models are available in single-stage units with capacities from 800 to 12,500 cfm. at compression ratios from 1.6:1 to 5.0:1—or in two-stage units with capacities from 2,000 to 12,500 cfm. at compression ratios above 5.0:1—and for booster service at maximum working pressures up to 250 psig.

Contact your nearby Fairbanks-Morse Branch, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.

Ask for new Bulletin ACO 100.1.

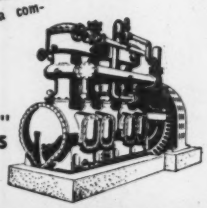
FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS · PUMPS · SCALES · DIESEL, DUAL FUEL AND GAS ENGINES
LOCOMOTIVES · ELECTRIC MOTORS · GENERATORS · MAGNETOS · HOME WATER SYSTEMS

Making dry ice at 109° below zero using standard ammonia compressors in an improved cycle.

"HEAVY DUTY" COMPRESSORS



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ENGINEERS

WILL DESIGN . . . BUILD *and* INSTALL FRICK SYSTEMS . . .

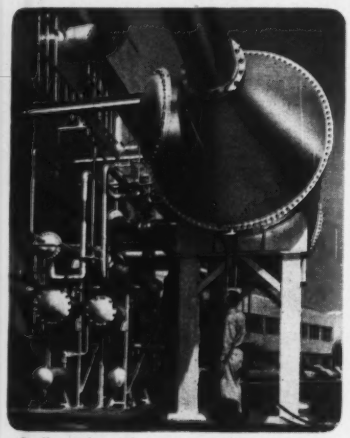
to solve your most difficult cooling problems.

If you need any type of industrial or commercial cooling—for quick freezing, cold storage, ice making, humidity control, low temperatures, condensing, air conditioning, or any process work—contact the nearest Frick Branch or Distributor for recommendations and estimates.

DEPENDABLE REFRIGERATION SINCE 1882

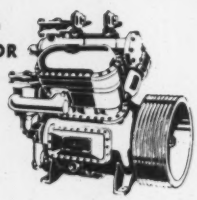
FRICK CO.

WAYNESBORO, PENNA., U. S. A.

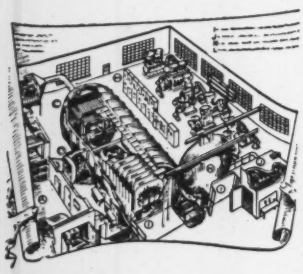


Cooling air under pressure for supersonic speed tests.

"ECLIPSE" COMPRESSOR



Test laboratory work for temperatures down to 140° below zero.



All-weather Laboratory built for U. S. Army. Uses 3-Stage compressors, mantains Arctic, tropic and stratospheric condititions.

YOUR *New Catalogs* GUIDE

315 VALVE OPERATORS

Ledeen Mfg. Co.—Bulletins illustrate and describe company's line of pneumatically or hydraulically operated valve operators for direct or remote control of gate, diaphragm and plug valves. Selection information, torque ratings, dimensions, and weights are given

316 DRAFTING EQUIPMENT

A. W. Faber-Castell Pencil Co.—The company offers three bulletins outlining some of their drafting materials. Described in detail are the Castell slide rules and scales as well as the Locktite Fleetline Holder, guaranteed dust-free because there is no sharpening or sanding.

317 GENEVA ATOMS CONFERENCE

Addison-Wesley Publishing Co., Inc.—A 16-page newsletter describes 12 volumes prepared under US AEC supervision and presented by the USA to delegates at the 1958 Geneva Atoms-for-Peace Conference. One volume is on controlled fusion (Project Sherwood) six on reactors, four on nuclear chemistry and metallurgy, and one on radiation biology and medicine.

318 AIR DIAPHRAGM CYLINDERS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes diaphragm air cylinders and diaphragm air chambers with effective areas from 9 to 50 sq in. and strokes from $1^3/_4$ to 4 in.

319 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages, needle valves, and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

320 MECHANICAL PACKINGS, GASKETS

Raybestos-Manhattan, Inc., Packing Div.—Selected packing types designed for custom-built service on 95 per cent of all packing applications are the subject of this 40-page catalog. The book contains descriptions, illustrations, service recommendations, and specification charts that cover over 100 different products in packing and gasket materials.

321 UNIT HEATERS

Grinnell Corp.—Catalog 58 illustrates and describes gas fired unit heaters. Information is given on unit location, mounting heights, length of throw, performance, specifications, weights, and dimensions.

322 LAMINATED PLASTICS

Formica Corp.—A condensed catalog of technical information describes services and product areas of the company's industrial products section. Included is information on Copperclad laminates, laminate sheet sizes, moldings, rods, tubes post-forming, and special NEMA and special grade charts and a comparator chart.

323 ASH SLUICING SYSTEM

United Conveyor Corp.—A four-page bulletin, No. 1S-57 describes recirculating closed circuit ash sluicing system with description of principle and sequence of operation.

324 HOT WATER CONVERTERS

Patterson-Kelley Co.—Bulletin 303-A contains construction and operating data for hot water heating convertors. Tables show how to select proper convertors for such applications as industrial and domestic water heating.

325 CENTRIFUGAL CASTINGS

Sandusky Foundry & Machine Co.—Catalog No. 200 explains how the centrifugal method produces a fine-grain, dense structure free of gas bubbles, slag, and non-uniformities, with desirable physical properties for circular or symmetrical parts. The firm's facilities for producing and machining cylinders in sizes from 7 to 54 in. OD, light or heavy-walled up to 33 ft in length, are described. Comprehensive alloy tables list characteristics of more than 70 stainless steel, steel, and nonferrous alloys available, and 86 present applications in 13 major industries are given.

YOUR

New Catalogs GUIDE

326 SQUARE HEAD CYLINDERS

Anker-Holth Div., Wellman Engrg. Co.—A 30-page data bulletin gives engineering specifications, ordering information for recently-introduced square head hydraulic cylinder line. Of tie-rod construction, line is rated for 2000 psi working pressures, up to 3000 psi in nonshock service. All mountings are available, standard bores range from $1^1/_2$ through 12 in. Standardized mountings are said to provide complete interchangeability with most makes of square head cylinders.

327 PIPE FABRICATION

Dravo Corp., Machinery Div.—Bulletin 1704 illustrates a part of the firm's record of engineering construction of pipeline pumping and compressor stations for the transmission and storage of gas and petroleum products.

328 HYDRAULIC HOSE

Flexonics Corp.—A 24-page catalog shows pressures and sizes of hydraulic synthetic hose. Fittings and factory crimped and field attachable types are included.

329 STEAM TRAPS, FLUID SPECIALTIES

V. D. Anderson Co.—A 36-page catalog contains engineering information on sizing steam traps, strainers, air release valves, and line type purifiers. Specifications, capacities sizes, pressures, weights on inverted bucket, thermostatic, float, combination and high pressure steam traps and other fluid specialties are given. Piping layouts are included.

330 HEAVY DUTY COMPRESSORS

Pennsylvania Pump & Compressor Co.—Single stage, horizontal, water cooled, heavy duty air compressors in sizes from 10 to 125 hp and for pressures to 150 psig covered in Bulletin 201-E.

331 COUNTING DEVICES

Veeder-Root, Inc.—Modern mechanical electrical, and electronic counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

332 FLASH BUTT-WELDING RINGS

American Welding & Mfg. Co.—A 20-page illustrated booklet describes how the firm produces rings and circular products. Photographs, drawings, and charts illustrate the methods used to form bar stock by bending and how it is welded to produce rings used in aircraft, missile, and other industrial applications. Specifications peculiar to flash butt-welded rings, quality control procedures, and testing are discussed.

333 TROLLEY CONVEYOR SYSTEMS

Conveyor Systems, Inc.—An eight-page brochure presents information and photos on power and free trolley conveyor systems. The equipment is designed for industries which can advantageously employ free-running line branches from main circuit of power conveyors.

334 MOTION PICTURE CAMERAS

Wollensak Optical Co.—A catalog explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity.

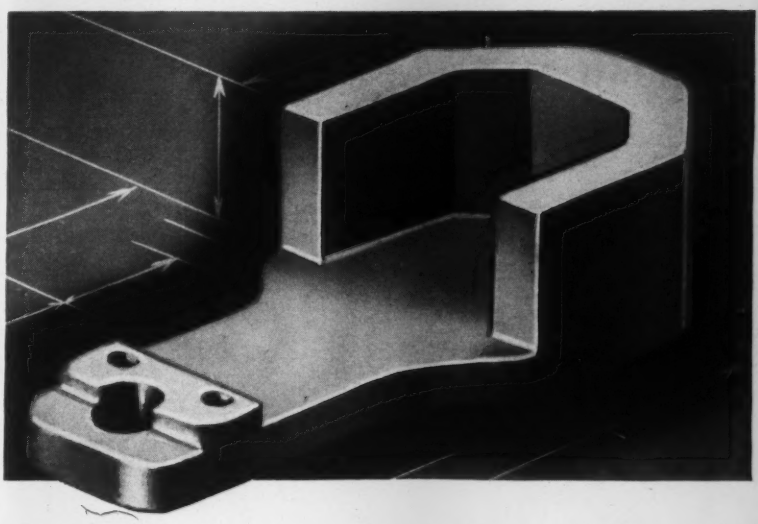
335 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Catalog 60 covers specifications, construction details, application data, and prices of their complete line of electric heating units. Models are available with strip, ring, tubular, and cartridge heating elements. Also described are immersion, circulation, radiant, and forced-air duct heaters. Charts and tables are provided.

336 OIL, FLUID SEALS

National Seal Div. Federal-Mogul-Bower Bearings, Inc.—Catalog 58 covers selection, application, maintenance of 40 different types of oil and fluid seals. More than 3000 sizes are listed.

economy...speed... in volume production of complex parts...



The photograph shows a bearing support plate for a new line of power tools manufactured and marketed by a large and very capable organization.

The complex nature of the part is apparent at a glance and the cost of machining such a part is evident to the eye of engineer and designer.

It is on parts of this nature that powder metallurgy offers its greatest advantages and its greatest opportunities for the future.

Such parts require most careful designing of the tooling from which they are produced, plus painstaking and tedious effort until the part can finally be produced in volume.

A manufacturer with such requirements naturally turns to Bunting where the necessary persistence until success is achieved is one of the Company's recognized characteristics.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze or sintered metals, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

The Bunting Brass and Bronze Company
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Bunting®

Branches in Principal Cities

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS.

NOW AVAILABLE

The Books you have been waiting for.

FLUID METERS

Their Theory and Application

This Fifth Edition includes information on a number of new types of fluid meters and metering procedures that have been developed in recent years. It is divided into three sections with the first giving the classification and nomenclature of fluid meters, together with definitions of special terms and other general information. The theory of fluid measurement and the steps taken to develop practical working equations from the theoretical relations are set forth in the second section. Figures and tables for use in solving practical fluid measurement problems, along with examples illustrating their proper use, are contained in the third section.

1959 **Cloth Binding** **$8.00***

FLOW MEASUREMENTS

Chapter 4 Part 5 Instruments and Apparatus

These test rules apply when the primary element is an orifice, a flow nozzle, or a Venturi tube. The fluid may be compressible or incompressible. The primary element may be installed within a continuous section of pipe flowing full, or at the inlet or exit of a plenum chamber. Specifically this Chapter includes information on the construction of these three primary elements, the recommended techniques governing tests, the necessary equations for computing rate of flow, examples to illustrate the application of typical data, a discussion of tolerances applicable to certain of the factors involved in the measurements, and an outline of the major advantages and disadvantages of various types of primary elements.

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YOUR *New Catalogs* GUIDE

337 PROCESSING SERVICE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 121-A describes SVS single stage, centrifugal pump developed for petroleum, petrochemical, chemical, and other processing services. Capacity ranges from 15 to 1300 gpm, discharge pressure to 600 psig, working pressure to 600 psig, differential head to 650 ft, temperature to 300 F, and speeds to 3600 rpm.

338 AMMONIA ABSORPTION REFRIGERATION

Black, Sivalls & Bryson, Inc.—Bulletin 33-10 illustrates and describes the firm's ammonia absorption refrigeration unit, an automatic system for the production of low temperatures for natural gas conditioning. The seven-page booklet contains specifications and diagrams. Eleven standard units are offered.

339 AIRCRAFT HANGAR HEATING

L. J. Wing Mfg. Co.—Bulletin HA-100 discusses the problems and types of systems used in heating aircraft hangars and illustrates and describes its units for steam, hot water, or gas heating. Photos and data on the company's installations for leading airline companies are included.

340 PROCESS INDUSTRY TUBING

Babcock & Wilcox Co., Tubular Products Div.—A 16-page bulletin, TB-417, is in illustrated booklet presenting information on the application of tubing, pipe, and welding fittings in the process industry. Selection of materials analyses, physical and mechanical properties of various tubing steels are included.

341 AIR, HYDRAULIC CYLINDERS

Anker-Holth Div., Wellman Engineering Co.—Brochure AD-3 describes and illustrates standard air and hydraulic cylinders and valves, including five types of air cylinders, four types of hydraulic cylinders, also rotating air and hydraulic cylinders.

342 CLOSE-COUPLED PUMPS

C. H. Wheeler Mfg. Co., Economy Pump Div.—Four-page catalog describes Type SCC close-coupled pumps. Applications include small cooling tower or air conditioning systems, domestic water supply, hot water heating system circulation, booster pumping or in package equipment. Catalog includes cutaway drawings, metallurgy, performance curves, and motor data.

343 CUSTOM GEARS

Cincinnati Gear Co.—Illustrated folder describes and shows examples of types of gears produced to individual specifications only for all types of machinery and products. Gear types listed include spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol (R) bevel and Coniflex (R) bevel; also custom gear boxes.

344 TECHNICAL BOOKS

Lefax Publishers—A revised catalog covers pocket size technical data books. The books cover every field of engineering, including aeronautics, air-conditioning, automotive engineering, diesel engineering, home heating, machine design, machinists' data, mechanical drawing, mechanics of materials, metals, piping data, power transmission machinery, steam engineering, thermodynamics tables and charts, general mathematics, five-place trig. and log. tables, heterogeneous mathematics tables.

345 RADIAL ENGINES

Nordberg Mfg. Co.—A 16-page bulletin describes radial engines, two-cycle diesel, spark-ignition gas, and dual-fuel. The bulletin, No. 200A, describes recent engineering and design features which include supercharging of the spark ignition radial engines for an increase in rating of approximately 50 per cent over normally scavenged engines.

346 WATER BAR SCREENS

Jeffrey Mfg. Co.—Catalog 952 contains sections on water and bar screens, grinders, collectors, settling tanks, scum removers, Floctrols (controlled flocculation), feeders, conveyors, bucket elevators, chains and sprockets for water, sewage and industrial waste treatment.

YOUR

New Catalogs GUIDE

347 STEAM GENERATOR

Mears-Kane-Ofeldt, Inc. Div., S. T. Johnson Co.—Bulletin S-C covers new horizontal steam generator available in 6½, 15, 25, and 33 hp sizes for use with gas, oil, or combination gas or oil.

348 BRONZE GLOBE VALVES

Lunkenheimer Co.—A four-page, three-color detailed circular 602-2 on the two pressure classes of LQ600 bronze globe valves, for a variety of services from normal to exceptionally severe, is offered. The two pressure classes—rated at 150 lb SP, 300 lb WOG, and 200 lb SP, 550 F, 460 lb WOG—are described, and all features of each are listed. ASTM, ASME and military specification numbers of alloy for bodies and bonnets are included.

349 REFUSE INCINERATOR WALLS

Bernitz Furnace Appliance Co.—Bulletin B-58 describes silicon carbide air-cooled blocks for incinerator walls. The blocks are designed to improve combustion, insure long furnace wall life, and reduce maintenance and down time.

350 STEEL SMOKE STACKS

Koven Fabricators, Inc.—Bulletin gives size, capacity, and engineering information on steel smoke stacks. A formula for figuring anchor bolts for self-supporting stacks and a formula for figuring guy wire for guyed stacks are included. A table also covers the effects of force of wind on stacks.

351 WORM GEAR DRIVES

Cleveland Worm & Gear Co.—A 16-page, illustrated brochure provides information on the firm's standard line of speed reducers, worm gear sets and special units.

352 MIDGET STEAM GENERATOR

Pantex Mfg. Co.—Bulletin, SG-200, describes the company's Series R model electrode principle steam generator and steam-jet cleaner. The unit is described as the first midget-size boiler for high pressure steam up to 250 psig and temperatures up to 405 F.

353 INSTRUMENTS, SYSTEMS

Gulton Industries, Inc.—A four-page scientific brochure covers the firm's instruments for shock, vibration, pressure, inertial control, temperature, and other devices for use as single components or in complete systems.

354 RING-LOCKED FASTENERS

Rosan, Inc.—Literature describes the firm's locking ring principle for positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials.

355 MAGNET DRUM SEPARATOR

Stearns Magnetic Products—Bulletin 1051 covers the Indox V drum separator for continuous and automatic removal of tramp iron in process industries. The bulletin explains how the ceramic magnet material produces a uniform magnetic field up to 40 per cent more powerful than in ordinary permanent magnet units.

356 BALL BEARINGS

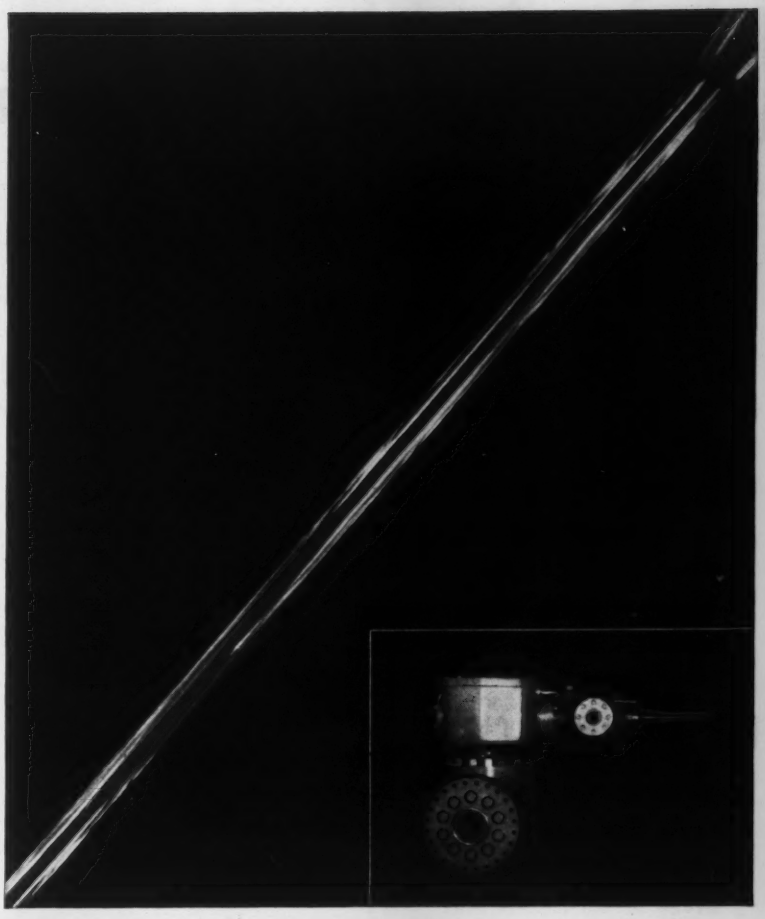
New Departure Div., General Motors Corp.—Dimensions, load ratings, and mounting fits are detailed in the 23rd edition of the company's ball bearing catalog. The 158-page book contains tables, drawings, and extensive selection data and specifications.

357 OVER-RUNNING CLUTCHES

Formsprag Co.—Four-page folder gives data on over-running clutches and shows how they can be applied in missiles and supersonic aircraft. Information is also given on the firm's special design service.

358 LUBRICATION RECOMMENDATIONS

Shell Oil Co.—A bulletin gives detailed lubrication recommendations for contractors' equipment, including gearing, wire ropes, pneumatic tools, power steering, etc. Another bulletin illustrates and describes the company's Rotella T oil, a heavy duty motor oil for truck fleet operators.



Using stop motion, photographer Bernard Hoffman "freezes" a tiny jet of water. Discharged at high pressure, the stream is a solid, unwavering mass.

SPLIT-SECOND CONTROL OF TIME AND PRESSURE

Take the valve pictured above. This 10-inch, high-speed Rotovalve was designed for rapid flow control at a Langley Field test installation. It will fully open, or close, in one-tenth of a second against water under free-discharge conditions at 3,260 pounds per square inch pressure.

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LATEST INDUSTRIAL LITERATURE

359 MACHINE DESIGN IDEAS

Lincoln Electric Co.—A series of pamphlets discusses basic approach to efficient design in steel. Current series covers fundamentals of design of component parts to simplify construction, also basic ideas of designing machine bases to increase rigidity and reduce cost.

360 PUMPS, SEPARATORS

Kraissl Co.—Bulletin A1803 gives information on air compressors and vacuum pumps, rotary positive displacement liquid pumps, separators, strainers, and filters. A list of regional sales representatives is included.

361 ELEVATED STEEL TANKS

Pittsburgh-Des Moines Steel Co.—Illustrated catalog on modern water storage contains information on dimensions and capacities of various types of elevated tanks: double ellipsoidal, obloidal, tripod sphere, pedestal sphere, radial cone, and hemispherical bottom. It also shows cutaway section of an elevated tank, illustrating construction details and accessories.

362 PRESSURE ACTUATED SWITCHES

Meletron Corp.—New 88-page catalog contains technical data, information, and illustrations covering pressure actuated switches, snap action switches, solenoids and a portable test bench. Included are gage pressure, differential pressure and absolute pressure actuated switches for corrosive and noncorrosive fluid and pneumatic applications.

363 PROPORTIONING OIL BURNER

Anthony Co.—Data sheet 501 describes Nebulyte proportioning oil burner, Type BI, and includes capacity table, dimension drawings, application sketches, and installation photographs. Also available are Data sheets BA, BD, and BL covering low and high-range oil burners and BG-H covering combination gas-oil burners.

364 FORGED STEEL GATE VALVES

Lunkenheimer Co.—Circular No. 607 describes new forged steel gate valves for service applications 800 psi at 850 F, 2000 psi at 100 F. They are made in screwed and socket welding end design. A large cutaway illustration shows design detail.

365 NAMEPLATE MARKING

Jas. H. Matthews & Co.—An eight-page bulletin illustrates and describes nameplate marking equipment from steel hand stamps to production machines.

366 AIR OPERATED CHUCKS

Cushman Chuck Co.—Catalog No. PO-65-1957, with companion price list, describes air operated chucks, rotating air cylinders, control valves, and accessories. It also includes typical installation and advantages of air chucking.

367 RIGID PVC PIPE

B. F. Goodrich Industrial Products Co.—Bulletin 10051-A covers properties, chemical resistance, design data, specifications, and installation of Koroseal rigid vinyl piping.

368 QUICK OPENING DOORS

Struthers Wells Corp.—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

369 HOT PROCESS SOFTENERS

Cochrane Corp.—Bulletin 4800 illustrates and describes hot process softeners for boiler plant water conditioning. Data is given on water treatment and the principles of operation of the firm's equipment are diagrammed.

370 TECHNICAL BOOKS FOR ENGINEERS

Ronald Press—Brochures containing detailed descriptions of current technical books on mechanics, engineering, aeronautics, industrial management, metallurgy, applied and physical sciences, etc. Practical reference works like the Ronald Handbooks, basic studies, and pioneering works on the latest engineering and scientific developments are included.

371 LEASE AUTOMATION SYSTEMS

Black, Sivalls & Bryson, Inc.—Packaged lease automation from wellhead to pipeline provided by the firm's new Phanto-Matic lease system, is described in a 20-page catalog. The system offers fully automatic wellhead shut-in control, well test control, well flow control, tank switching, custody transfer, fluid metering, and lease safety controls.

372 CHEMICAL TREATMENTS

Layne & Bowler, Inc.—Six-page folder illustrates and describes chemical treatment for water wells. It lists treatment materials and shows microphotos of bacteria found in wells.

373 SCAFFOLDING DEVICE

Western Gear Corp.—Bulletin 5909 covers Sky Climber, a new scaffolding device, adaptable to bosun chair or swing stage operation, and available for manual, air power, or electric powered operation. Each unit is capable of lifting 1000 lb.

374 WELDING ALUMINUM

Aluminum Co. of America—A 176-page hard cover book gives basic, practical data on the various processes for welding aluminum with special emphasis on the inert gas methods. Included is guidance in selecting the process and the alloy. One chapter is devoted to the performance of welds. Illustrated, 32 tables. Form 10415.

375 REVERSING DRIVE

Funk Mfg. Co.—A catalog illustrates and describes the firm's Reverse-O-Matic drive said to be adaptable to any equipment that has forward or backward, or up and down motion, such as road rollers or fork lift trucks. One-lever controls speed and change of direction. Standard flanges adapt it to other power transmission components, including power take-offs, right-angle drives, transmission, and gear reduction.

376 MECHANICAL VIBRATING FEEDER

Carrier Conveyor Corp.—Bulletin 591 gives details and dimensions of the new natural frequency Amplitrol feeder. The drive consists of a standard low frequency a-c motor in straight line vibration between heavy duty pneumatic control springs. There are no moving parts to lubricate —no sheaves, gears, large bearings, variable speed drives, rectifiers, magnetic or electronic controls. Capacity is controlled by varying air pressure in the pneumatic springs.

377 METERING PUMPS

Hills-McCanna Co.—Bulletin 900 illustrates and describes new Masterline metering pumps. Each model is crowned by a streamlined functional safety shield, and is powered by standard NEMA foot-mounted motor. Typical metering systems for the process industry are diagrammed.

378 DRAFTING DESK

General Fireproofing Co.—A folder illustrates and describes a drafting desk which has a belt positioning control that permits the draftsman to work on any part of his drawing while he remains seated in his chair.

379 PROCESSING EQUIPMENT

Permutit Co. Div., Pfaudler Permutit Inc.—A bulletin gives data on aerators, degasifiers, deaerators, chemical feeders, precipitation equipment, filters, ion exchange equipment, gas analysis and control systems, valves, meters, flow controllers. Application photos show the equipment in various industries.

380 HYDRAULIC MULTIPRESS

Denison Engrg. Div., American Brake Shoe Co.—Catalog 120 illustrates and describes the firm's hydraulic multipress in 10 sizes from 1 to 75 tons capacity. General specifications and diagrams are included for the various models and accessories.

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381 LOW TEMPERATURE HEAT RECOVERY

Green Fuel Economizer Co.—Illustrated folder describes construction and operation of the firm's latest cast-iron economizer, which has been specially designed for low temperature heat recovery from flue gas under adverse conditions. A circuit diagram shows one of several alternative methods of transferring the recovered heat back into the system.

382 IMPLEMENT BALL BEARINGS

New Departure Div., General Motors Corp.—A booklet illustrates and describes ball bearings for use on farm implements. The 24-page booklet has cutaway photos, drawings, dimension, load rating tables for a variety of farm applications.

383 AUTOMATIC DATA SYSTEMS

Hagan Chemicals & Controls, Inc.—Bulletin MSP 161 describes Kybernetes automatic data handling systems. The electronic equipment logs, monitors, computes any number of input variables at better than 0.1 per cent overall full scale accuracy. Bulletin includes basic design parameters and technical description of various stages of the equipment.

384 SPROCKETS, COUPLINGS

Acme Chain Corp.—Catalog covers Grip-Master stock sprockets and flexible couplings for roller chains. Full dimensions, revised prices, mounting and dismounting instructions, and engineering data are included.

385 DIAPHRAGM VALVES

Hills-McCanna Co.—Six-page bulletin covers diaphragm valves for every type of pipe. The bulletin contains data on selecting valves for process piping systems, the advantages of diaphragm valves and their ability to meet pipe specifications.

386 OIL AND GREASE

Shell Oil Co.—Technical bulletins cover Darina grease, a multi-purpose microgel grease, and Dromus Oil E, a lubricant for high-speed metal machining operations.

387 TORQUE CONVERTERS, TRANSMISSIONS

Rockwell-Standard Corp.—Bulletin SP-5803 illustrates and describes Hydra-Drive torque converters. SP-5804 covers power shift transmissions. Specifications, engineering data and selection charts are included in both bulletins.

388 ALUMINUM HANDBOOK

Aluminum Co. of America—A hard cover book contains data on aluminum alloys and mill products in tabular form. Information is given as reference for those responsible for planning, designing, testing, purchasing, and fabricating aluminum successfully. Form 10051.

389 AUTOMATIC MECHANICAL CLUTCHES

Mercury Clutch Div., Automatic Steel Products, Inc.—An eight-page folder gives specifications, applications and special data on the two general types of clutches for gasoline engines and electric motors. Also listed are representatives who are qualified to assist in the proper selection and application of the firm's clutches.

390 STORAGE WATER HEATERS

Patterson-Kelley Co.—Catalog 19 gives capacities and weights, dimensions, conversion tables, fixture capacities, material thicknesses, heating elements and construction details of storage hot water heaters.

391 PIPE HANGERS

National Valve & Mfg. Co.—Bulletin 157 gives specifications for Counterpoise hangers, designed to provide a constant load supporting capacity for piping systems subject to vertical movement caused by expansion and contraction of piping with temperature changes. Levelglide hangers, which permit horizontal movement of piping systems. also are described

392 COMBUSTION EQUIPMENT

Hauck Mfg. Co.—The Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations.

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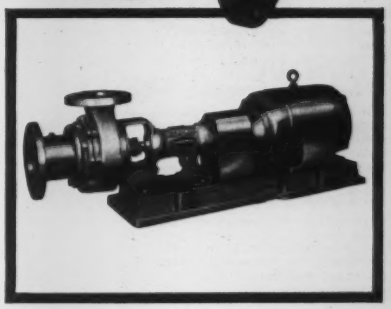

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WRITE FOR BULLETIN 119-C

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LATEST INDUSTRIAL LITERATURE

393 CONTROLLED-AIR-DEVICES

Bellows Co.—Bulletins BM-25 and ML-3 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-3 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

394 STAINLESS, SPECIAL PURPOSE ALLOYS

Carpenter Steel Co.—A 12-page booklet contains information on selection, properties, corrosion resistance and workability of stainless steels. Also included is a description of alloys available for electronic, magnetic and electrical applications, and alloys for elevated temperature service.

395 DEMINERALIZING

Cochrane Corp.—A 40-page "Handbook on Demineralizing" compares various methods of water treatment, and demineralizers and evaporators. Characteristics of various types of cation and anion exchange materials are discussed and data on operating costs is included.

396 TURBINE SEAL

Koppers Company, Inc., Metal Products Div.—A 4-page folder on Huhn carbon rings for steam turbine applications discusses labyrinth, carbon garter spring ring and carbon ring sealing devices.

397 HARD CARBIDES

Kennametal, Inc.—A 44-page booklet describes basic design principles for use of hard carbides; methods of forming; methods of fastening carbides mechanically; and a general treatise of Kennametal and suggested fields of application.

398 MATERIALS HANDLING

Syntron Co.—A condensed catalog, No. 591, contains 68 pages of technical data, brief description and photographs of bin vibrators, vibratory feeders, vibratory conveyors, power tools, shaft seals, selenium rectifiers, vibrating parts feeders, and other equipment.

399 AIR DIRECTIONAL VALVES

Westinghouse Air Brake Co., Industrial Products Div.—An eight-page catalog describes two-, three-, and four-way spool type directional valves with solenoid, lever, push button, pilot cylinder, cam, treadle, and pedal operators. Valves have tapped exhaust or open exhaust. In neutral, spools close all passages, connect delivery passages to exhaust or connect delivery passages to supply.

400 AIRCRAFT BALL BEARINGS

New Departure Div., General Motors Corp.—A 16-page booklet covers the application of ball bearings in the aircraft industry. Charts show the effects of load and speed, and tables show dimensions of bearings in a variety of flight applications.

401 STAINLESS STEELS

G. O. Carlson, Inc.—A four-page folder shows applications of stainless steel in plates, plate products, heads, rings, circles, forgings, flanges, bars, sheets. Products, equipment and services of the firm are discussed.

402 MATERIAL DISTRIBUTION

Carrier Conveyor Corp.—Bulletin 581 describes how natural frequency conveyors can distribute single or multiple material on a single conveyor to several screens, crushers, mills, extruders, bins, either alternately or simultaneously.

403 CENTRIFUGAL PUMPS

Pacific Pumps, Inc., Div. Dresser Industries, Inc.—"The Choice, Design, Characteristics and Maintenance of Centrifugal Pumps" is a reprint in booklet form of three published articles.

404 GAGING CARTRIDGES

Sheffield Corp.—A 32-page booklet gives application data on the use of Plumjet air gaging cartridges with instruments. Included are types, sizes, amplification tolerance, and range of the units. Engineering and technical data for applying them to single and multiple dimension inspection and machine control is included.

405 RESEARCH FACILITIES

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin D-1005 illustrates and describes the firm's expanded and improved test and research center for basic equipment, for Portland cement, lime, asbestos, phosphate, light-weight aggregate.

406 PROCESS CONTROL

Swartwout Co.—Bulletin describes electronic control and instrumentation for processing, power generation (including atomic energy), testing, research, and development. Principles of electronic transmission and control are discussed together with benefits, i.e., zero transmission lag, zero hysteresis and infinite resolution by continuous (stepless) modulation.

407 HEAVY DUTY V-BELT

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M210 describes a new Condor I.S V-belt made for long center, heavy duty drives. The belt features a precision proportioned construction to eliminate V-belt whip and turn-over.

408 VIBRATION ISOLATION

Korfund Co.—A four-page bulletin gives information on how to write vibration isolation specifications for air conditioning and related equipment. It contains a definitive treatment of the factors involved in the selection of various isolation media commercially available and has a selector chart designed to simplify writing specifications. Bulletin F2C.

409 FOUR-WAY VALVES

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 240 covers four-way valves designed for shockless hydraulic control on any directional equipment. A cutaway photo illustrates the pilot-operated, solenoid-controlled unit, and application data is given.

410 LIQUID LEVEL CONTROLLER

Leslie Co.—Bulletin 583 covers the firm's Level-Matic liquid level control pilot. Characteristics, design advantages, and installation facts, and how its simplicity and adjustable proportional band eliminate problems associated with other methods are included.

411 COPPER CHARACTERISTICS

American Brass Co.—Publication B32 provides tables listing some of the properties of standard Anaconda copper and copper alloys. Included are compositions, forms available, certain physical properties, fatigue strength; creep strength, welding rods.

412 LONG TRAVEL RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 2111 describes new Series 300 IK long travel retracting soot blowers, for cleaning boiler tube banks in very hot locations. Positive drive by single, enclosed air or electric motor. Improved nozzle provides better cleaning with greater economy. Positive closed pitch helical blowing pattern assures full coverage of all surface.

413 DIESEL, DUAFUEL ENGINES

Nordberg Mfg .Co.—Series 29, two-cycle diesel and duafuel engines for stationary and marine service are described in a 16-page bulletin, No. 235A. With 29-in. bore and 40-in. stroke these engines are claimed to be the most powerful single action, two-cycle engines built in America.

414 CONVEYOR BELTING

Manhattan Rubber Div., Raybestos-Manhattan, Inc.—Catalog 25CB illustrates and describes conveyor and elevation belts. It covers new style designations of general service heavy duty types made with special strength numbers. Tension ratings, minimum pulley diameters and minimum belt widths are given.

415 ALUMINUM, MAGNESIUM CASTINGS

American Brake Shoe Co.—Brochure shows how precision, high-strength castings in light alloys can reduce weight, improve design, and cut costs in critical airborne components. Listed are mechanical properties guaranteed in castings of aluminum and magnesium alloys; government specifications for casting and inspection methods.

416 HYDRAULIC PULSATION DAMPENER

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes a device that suppresses the pulsations and pressure surges which reciprocating pumps, centrifugal pumps and quick closing valves introduce into hydraulic systems.

417 HYDRAULIC CAR SHAKER

Stephens-Adamson Mfg. Co., Engineering Div.—Bulletin 658 presents comprehensive technical data, drawings, and illustrations of the Carquake, hydraulically powered car shaker.

418 VIBRATING EQUIPMENT

Carrier Conveyor Corp.—Bulletin 582 describes uses of natural frequency vibrating equipment in the production of polyethylene pellets, the compounding of plastic cubes, and the processing of plastic powder or flakes. Operations illustrated are conveying, feeding, dewatering, drying, cooling, heating, screening, distributing, scalping, coating, and elevating.

419 TECHNICAL BOOKS AND PAPERS

The American Society of Mechanical Engineers—A 20-page catalog describing current books, standards, codes, research reports and periodicals published by the Society and a listing of available technical papers.

420 SPEED REDUCERS

Farrel-Birmingham Co.—Bulletin No. 450, "Farrel Speed Reducers," illustrated 52-page booklet contains full information about speed reducers. Included are horsepower rating table, specifications, dimensions, weights, and other data required for quick selection of speed reducers for various applications.

421 PROCESS EQUIPMENT

Hardinge Co.—Eight-page brochure, Bulletin 100-B, gives information on process equipment for mining, chemical, stone, ceramics, water, sewage, and industrial waste applications. Equipment for the following process operations are included: agitating and mixing, balling or pelletizing, clarifying, wet and dry classifying, cooling, drying, filterings, feeding, flocculating, grinding or pulverizing, lime treating, sampling, ore scrubbing, heavy-media separating and thickening. Laboratory or pilot-plant size equipment, for pulverizing and drying, is also described.

422 DRAFT GAGES

Ellison Draft Gage Co.—Offers new 16-page Bulletin No 109 D describing draft gages, vertical tube gages, and pitot tubes. Shows full range of sizes, prices, and gives application information.

423 GLASS INSULATION

Pittsburgh Corning Corp.—Six specifications cover application of the firm's Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, detail drawings of installation procedure, insulation supports.

424 ALUMINUM CASTINGS

Morris Bean & Co.—Booklet on the Antioch Process offers a brief description of the process used currently in the production of aluminum castings weighing up to 2000 lb and up to 10 ft in diameter. Loose specification sheets covering applications in aircraft, missile, electronic, and fluid flow fields are available.

425 BOILER SERVICE VALVES

Everlasting Valve Co.—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y-Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. A section of the bulletin also describes Everlasting Valves for fire protection.

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LATEST INDUSTRIAL LITERATURE

426 TORQUE CONVERTERS

National Supply Co.—Bulletin No. 496 describes single-stage torque converters for heavy industrial service, discussing background, design, types, sizes, circuits and applications. It also contains a capacity chart of the six sizes and 17 input ratings. Data sheets give application and dimension data of each of the six sizes, with performance curves, capacity chart, important features and typical torque converter arrangements.

427 MOYNO PUMPS

Robbins & Myers, Inc.—An eight-page brochure describing the history and added benefits derived from use of the Moyno pump. Phases detailed about this "progressing cavity" pump includes its principle of operation, performance, construction, capacities, and speeds.

428 STEREOMICROSCOPES

Bausch & Lomb—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included. Catalog D-15.

429 CENTRALIZED LUBRICATION

Farval Corp.—An illustrated brochure, No. 26-S, offers 20 pages of material relating to centralized systems of lubrication. The booklet discusses principles of operation, product advantages and system components.

430 FANS, BLOWERS

Robinson Ventilating Co.—Bulletin 502 illustrates and describes fans, blowers, exhausters. Application photos are included, along with data on air properties, pressure and velocities.

431 SHAFT MOTION INDICATORS

Bin-Dicator Co.—Catalog describes and illustrates Roto-Guard shaft motion indicator, a compact, low-cost unit for attachment to machines in process and other industries to give positive indication of motion, slow-down or stoppage of machinery. Can actuate signals, controls. Dimensional drawings, mounting details are included.

432 ROTARY SLITTING LINES

Yoder Co.—A 75-page handbook provides information on slitters and allied equipment. Basic data on design, selection and operation of slitting lines, and specifications of slitters, uncoilers, recoilers, coil cars, and scrap choppers are included.

433 GAGING APPLICATIONS

Sheffield Corp.—A 12-page booklet shows how column type Precisionaire gages are used to inspect single and multiple, internal and external dimensions and other geometrical conditions and relations.

434 HAND FORGINGS

Aluminum Co. of America—A booklet answers questions on high-strength, low-weight advantages of aluminum for parts of limited production. The booklet presents detailed discussions of factors that influence the production of quality hand forging. Form 10595.

435 CURVE CROWN PULLEY

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 558 illustrates and describes the firm's new curve crown pulleys. The literature features technical and engineering data, specifications on the new welded, all steel pulley.

436 LIQUID METERING EQUIPMENT

Black, Sivalls & Bryson, Inc.—The firm's line of fully automatic liquid metering equipment for handling lease produced liquids is outlined in a 24-page catalog. The line includes metering separators, chambers, tanks and test treaters. Any of the items may be used independently or as an integral part of the firm's lease system.

437 REDUCTION CRUSHERS

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 58-D illustrates and describes the company's line of reduction crushers giving tables and dimension drawings. Capacities and performance data and installation photographs are included.

438 SHORT-FLAME BURNER

Thermal Research & Engrg. Corp.—A four-page brochure describing thermal vortex type burners shows photographs of the flame characteristics with the burner operating on residual fuel oil and also operating with gas. The very short flame characteristic is described, particularly with regard to various types of heat equipment on which the burner might be used. Typical piping diagrams are also shown. A capacity chart for outputs up to 50 million Btu per hour is given.

439 OILLESS BEARINGS

Graphite Metallizing Corp.—Catalog 4 illustrates and describes solid and split self-aligning pillow blocks and hanger bushing assemblies with Graphalloy oilless bushings. They are designed to operate dry to 700 F in air in dryers, ovens, conveyors, kilns, refuse burners.

440 HOT-WATER BOILERS

Boiler Engrg. & Supply Co.—Bulletin BE 200 illustrates and describes exclusive features that have enabled Continental hot-water boilers to maintain the record of never having suffered from thermal shock.

441 VIBRATING FEEDERS

Syntron Co.—A 32-page catalog covers standard and special model electromagnetic vibrating feeders for hard-to handle bulk materials. Descriptions, data, and specifications along with installation photos and application diagrams.

442 DEAERATORS

Permutit Co. Div., Pfaudler Permutit Inc.—Bulletin No. 2357 describes the company's spray type deaerating heater. The principles of deaeration and the part it plays in corrosion prevention are described and illustrated. The deaerating heater is designed to protect equipment from corrosion by removing oxygen, carbon dioxide and nitrogen.

443 NUCLEAR FORGINGS

U. S. Steel Corp.—Six-page folder describes and pictures such forgings as rings, disks, closure heads, and vessel flanges, available for use in nuclear reactor construction.

444 ALUMINUM FABRICATION

Aluminum Co. of America—A 12-page booklet illustrates and describes the engineering, fabricating, welding, finishing, testing, and inspecting facilities at the firm's jobbing division.

445 BELT CARRIERS

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 355 lists carriers for belt conveyors and shows their application in industry. Cross sections and dimension tables are given for the various carriers.

446 PILLOW BLOCKS

New Departure Div., General Motors Corp.—Ten-page bulletin illustrates and describes ball bearing pillow blocks. Construction features, load ratings, dimensions, interchange data, and engineering data is included.

447 SILVER BRAZING OUTLETS

Bonney Forge & Tool Wks.—Brazolets used for silver brazing outlets to copper or brass pipe or tubing are described in this bulletin. The outlet portion is brazed or screwed. This construction is said to allow rapid installation of random length mains and attachment of outlets.

448 BOILER-FEED PUMPS

Worthington Corp.—Bulletin 2131-B1 illustrates and describes Types UNB and UNQ two- and four-stage centrifugal boiler-feed pumps in capacities to 2500 gpm, heads to 900 ft. Cross sections of each type are shown, along with dimension diagrams.

449 SPECIAL TRAILERS

Rogers Bros. Corp.—A catalog illustrates typical special trailers custom-built to carry loads from 5 to 250 tons, including transformers, reactors, engine-generator sets, shovels, and pre-stressed concrete beams. The trailer is designed to become integral part of finished products such as mobile power-units and mobile substations.

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General: Reactor Location and Type. Owner, Operator, Designer, Constructor. Cost of Reactor Facility. Operating Staff. Annual Operating Cost. Status. Design Power. Normal Operating Power, Power Density, and Specific Power. Operating Schedule. Principal Use of Reactor. To Whom Available for Research? **Fuel:** Normal Fresh Fuel Loading. Total Fuel Inventory. Expected Average Burnup Before Reprocessing. Fluid Fuel. Solid Fuel. Method of Refueling. **Reactor:** Over-All Active Core Dimensions. Core-Containing Vessel Dimensions, Materials and Mean Operating Pressure and Temperature. Moderator. Reflector Thermal Shield. Biological Shield. Reactor Control. **Primary Coolant:** Fluid. Circulation. Heat Dissipation Method. Average Core Heat Flux. Ratio of Maximum to Average Heat Flux. Means of Purification. **Nuclear Data:** Fuel Loading. Fluxes. Reactivity Coefficients. Burnable Poisons. **Research Facilities.**

Data collected on each reactor are presented on a separate three-page form, the latter having been specially designed to facilitate their use.

Additionally, there are diagrams on reactor facilities, notes on special features, and other supplementary material.

Published, March 1959, 304 pages. 8½" x 11". $7.50 a copy, 20% discount to ASME members.

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450 SOLIDS—CONTACT REACTORS

Cochrane Corp.—A 24-page bulletin on solids-contact reactors contains a cut-away photograph and several pages of plan and elevation drawings showing the variety of designs available. The bulletin discusses theory and problems of cold water clarification, advantages and applications of various designs. Auxiliary and supplemental apparatus is described.

451 SYNTHETIC RUBBER

B. F. Goodrich Chemical Co., Div. of B. F. Goodrich Co.—"Everywhere in Industry—Hycar Rubber," 24 pages, describes Goodrich Hycar rubber and its properties, using text and tables. General applications and uses are suggested for the different types and blends available.

452 INDUSTRIAL COOLING FANS

Koppers Company, Inc., Metal Products Div.—A 4-page folder illustrates and describes new, all-metal, "Precision-Engineered" Aeromaster fans for cooling towers and radiator-type coolers. Design features are discussed.

453 RAILROAD CAR SHAKER

Webster Mfg. Inc.—Bulletin 60D illustrates and describes the firm's car shaker, a cradle type unit weighing 3600 lb and powered by 10-hp motor. The shaker is capable of unloading coal, stone, gravel from hoppered bottom cars.

454 OIL-RETAINING BEARINGS

Bound Brook Oil-Less Bearing Co.—More than 600 of the most widely used sizes of oil-retaining porous bronze bearings are listed in the firm's Stock List No. 4. Also provided is condensed information on application, installation, lubrication and machining.

455 BELT FEEDER

Omega Machine Co. Div., B-I-F Industries, Inc.—Design features of Model 37-20 belt type gravimetric feeder are covered in Bulletin 35-N62. Unit is designed to feed more than 3000 lb per min.

456 GEAR REDUCERS

Lovejoy Flexible Coupling Co.—Form R-58 illustrates and describes 18 models of shaft mounted gear reducers in speeds of 8 to 425 rpm, fractional to 120 hp, ratios of single 4.5:1 nominal and double 14.7:1 nominal, and with hollow shafts of $1^{7}/_{16}$ to $5^{15}/_{16}$ in.

457 COMPRESSION PACKINGS

E. F. Houghton & Co.—A catalog describes a new, simplified line of rod and sheet packings. The firm manufacturers hydraulic and pneumatic packings of rubber, Teflon, and leather.

458 VENTURI TUBES

Builders-Providence, Inc., Div. B-I-F- Industries, Inc.—Design features, comprehensive dimensional data, capacity tables, recovery tables on venturi tubes are included in Bulletin 110-N1A.

459 ENGINE POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Circular is available containing illustrations, line drawings, description, and complete information on size and capacity of this unit designed for especially rugged heavy-duty service, operates without a pilot bearing and requires lubrication only once per year.

460 COMPRESSORS, GAS TURBINES

Clark Bros. Co.—Bulletin No. 151 describes compressors and gas turbines for the petroleum, gas, refining, chemical, petrochemical, and general industries. Specifications given on the following machines: Packaged field compressors, two cycle gas-engine-driven compressors, balanced/opposed processed compressors, multi-stage centrifugals, pipe line boosters, and gas turbines.

461 ELECTRIC CLUTCHES

I-T-E Circuit Breaker—Catalog 6304-1A describes electro clutches, for engaging and disengaging machinery gears and drives. The 20-page catalog provides application information and specifications and dimensions on the firm's complete clutch line.

462 REFRACTORY BRICK

Norton Co.—A 24-page booklet covers refractory brick and other fired shapes. Materials available, methods of manufacture, properties and characteristics, tables, graphs, and conversion charts are included.

463 BRONZE BEARINGS

Bunting Brass & Bronze Co.—Catalog 258 lists 343 stock sizes of cast bronze electric motor bearings for all makes and sizes of electric motors. These are made exactly to dimensions of original equipment and fit without further finishing.

464 SHORT RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 1079A describes improved Model IR short retracting soot blower for cleaning water cooled boiler furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. Operates in extremely hot zones. Air motor, electric motor or manual operation. Automatic cycle.

465 STRUCTURAL PANEL

Philip Carey Mfg. Co.—A folder, Form No. 6293 describes a 2-in-1 insulated structural panel for interior use in duct construction, industrial ovens, coil housings, plenum chambers. It is formed of laminated plies of corrugated and flat asbestos paper sheets, bonded with a fire-resistant adhesive suitable for continuous temperature up to 1000 F.

466 FORCED, INDUCED DRAFT FANS

Green Fuel Economizer Co., Fan Div.—The company offers bulletins covering: (1) mechanical draft fans: (2) airfoil type fans; (3) fly ash collectors; (4) economizers.

467 CUSTOM MOLDING TEFLON

Sparta Mfg. Co.—A four-page brochure covers patented process of custom molding parts of Teflon in thin sections and shapes. Properties and characteristics of Teflon, suggested end uses, and illustrations of such parts designed through the process as cup, ball, or shaft seals, washers, gaskets and diaphragms are included.

468 AIR COCKS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes plug type and diaphragm type two and three-way cut-out cocks for pneumatic systems.

469 LEADED STEELS

Copperweld Steel Co., Steel Div.—A booklet illustrates and describes the advantages of leaded steels and gives case histories of its use in a variety of products. Mechanical properties, machinability, and the chemistry of the products are listed in tabular form.

470 STORAGE TANKS

Hammond Iron Wks.—A 36-page catalog describes storage systems, including patented floating tanks of Tubeseal or Springtite construction, Vaporlift systems, Diaflote tanks, Dialift systems, underground storage tanks, water storage tanks and treatment vessels, and the recently introduced Hamondflote cover for small vertical tanks.

471 VALVES, CONTROLS

Hays Mfg. Co.—A packet of data sheets covers the firm's lines of solenoid valves, controls, strainers and automatic interlocks. Specifications, dimensions and flow charts are given.

472 TOOL STEELS

Crucible Steel Co. of America—A six-page index to Crucible tool steels and AISI type classifications. The cross index is an aid to making an accurate identification and selection of tool steels for specific jobs.

473 ELECTRICAL CONTROL CABINETS

Industrial Equipment Co.—Brochure shows sizes and construction of metal cabinets for electrical and hydraulic control panels. Special types are also shown.

YOUR

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LATEST INDUSTRIAL LITERATURE

474 STEEL PRODUCTS

Aristoloy Steel Div., Copperweld Steel Co.—A 48-page catalog presents electric furnace steel production, melting, rolling, finishing, thermal treating, and conditioning. It includes listing of blooms, billets, slabs, and bars, available in standard and special analysis, including those that can be leaded. Rolling limits and chemical analysis are also shown.

475 CYLINDERS, CONTROLS

Westinghouse Air Brake Co., Industrial Products Div.—Three bulletins are offered. F9-180.00 covers basic pneumatic air controls; DO-OO-2 lists catalogs covering the division's line of products; D3-41.01 describes double acting, cushioned and non-cushioned streamlined cylinders.

476 DRAINLINES

Corning Glass Wks.—Eight-page, two-color bulletin on Pyrex pipe for drainlines contains case histories. Photos show installations, methods of installing, fittings available, ways to fabricate odd lengths on the job. Check list of acids to which the pipe is resistant is also included.

477 BALL BEARINGS

Federal Bearings Co.—Catalog D-1 contains 24 pages of dimensional tables for selection of ball bearings according to size, and assists in the identification of ball bearings for which a replacement is required. Both metric and inch measurements are shown. Catalog also includes interchange and conversion tables.

478 INSTRUMENT BALL BEARINGS

New Departure Div., General Motors Corp.—A 36-page booklet illustrates and describes ball bearings for use in precision instruments. Tables, charts, and diagrams show the various series in a wide range of applications.

479 CYLINDRICAL ROLLER BEARINGS

Aetna Ball & Roller Bearing Co.—New illustrated catalog covers basic roller bearing types, standard series types, interchange data of series types. Detailed tables give dimensions of the basic types; housing bore limits for outer race fits. Data on inner race and outer race fits; load capacity charts and rating chart based upon AFBMA ratings; information on cylindrical roller thrust bearings.

Your NEW CATALOGS GUIDE offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 479 items to make selections from. For convenience an index may be found on pages 151-153. Select desired catalogs by number, requests limited to 25 catalogs. Fill in coupon on page 152 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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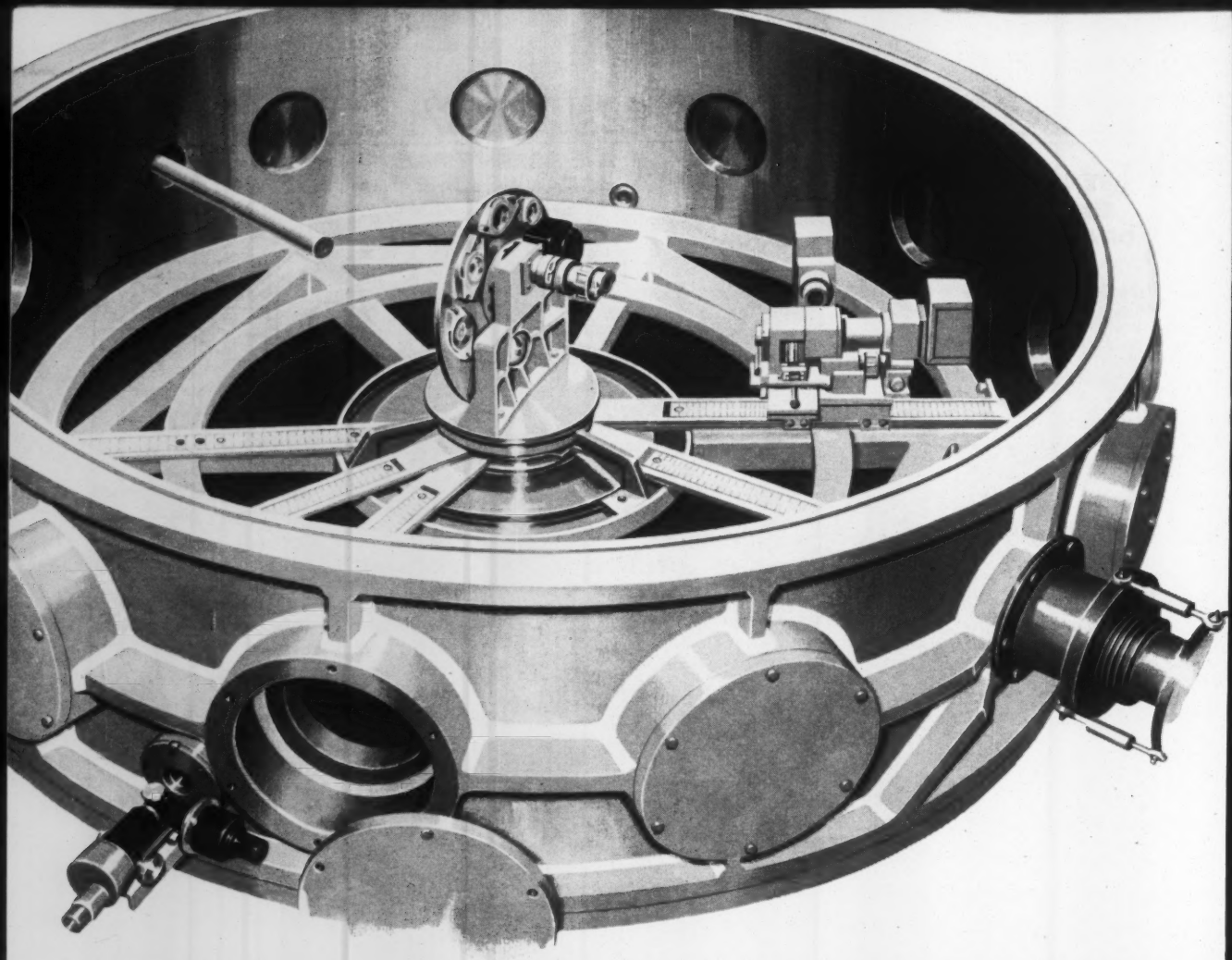

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A critical test of new ideas on nuclear structure and the theory of nuclear reactions lies in the measurement of the angular distributions of reaction products and their angular correlation. A high degree of precision in the experimental data facilitates a detailed comparison with theoretical predictions. The unique equipment for the scattering program with the Argonne 60-inch cyclotron is specifically designed for a variety of new experiments. The remotely controlled 60-inch scattering chamber has been constructed to permit the accumulation of data of the highest precision at a much greater rate than previously achieved.

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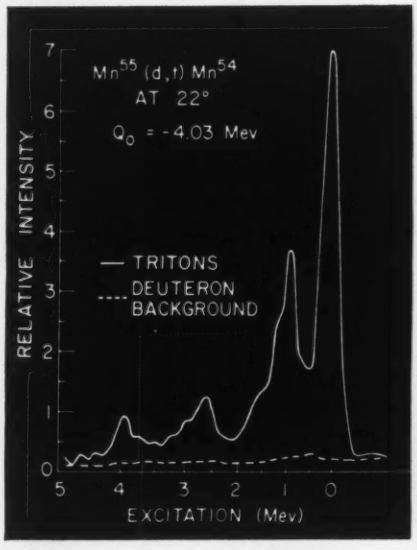

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Wherever you need constant air pressures up to 5500 cfm, these dependable "Buffalo" Blowers will do the job most efficiently and economically. Compact, ruggedly-built, direct-connected "Buffalo" Type "E" Blowers and Exhausters are available in eight sizes. Pressures up to 2 lbs. mean you can choose the units exactly suited to your needs.

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HAGAN NEWSLETTER
Behind the Panel

THE QUALITY OF MEASUREMENT FIXES THE QUALITY OF CONTROL

Control can only be as precise as the measurements on which it is based. Not only the measurement, but also the means by which it is transmitted to the recording or actuating mechanisms must be as near perfection as possible if a high degree of control quality is to be maintained. Here are some examples of how Hagan achieves exact control by means of accurate measurements:

MEASUREMENT SPAN CRITICAL IN REDUCING TEMPERATURE VARIATIONS

A large eastern steel mill was seeking a temperature controller for continuous strip annealing furnaces—a process that threads light gauge, cold rolled steel through the high temperature furnace in the range of 800 ft/min and provides fully recrystallized steel, ductile in spite of its relative hardness, with other desirable physical properties. They set up a Hagan PowrAmp and a competitive controller side by side on two new furnaces. The suppressed range feature of the PowrAmp made possible the holding of temperature variations to 2-3F—its span was set at 1,500 to 1,700F for the test. On the basis of these very acceptable results, which the competitive controller could not match, the PowrAmp was put in control of the temperature on these two lines. Later, when two more annealing lines were added, PowrAmp temperature controllers were selected—resulting in Hagan control of all four annealing lines at the mill.

SOAKING PIT REAL TEST OF METER TURNDOWN RANGE

When ingots start to heat in a soaking pit, maximum fuel firing is required. But later in the cycle, only enough fuel to maintain the desired temperature is needed. This may be less than 10% of max. Hagan Ring Balance gas and air flow meters, calibrated for a maximum differential of 10"WC, are accurate with as little differential as .035"WC, or about 6% of the full scale of the meter. This means that fuel-air ratios are maintained exactly throughout the full soaking pit cycle. Particularly critical when special alloys are being heated, precision ratio control pays off across the board in maintenance of quality and in fuel savings. (Item C-1)

MEASURING STEAM FLOW WITHOUT A PRIMARY ELEMENT SAVES MONEY

High pressure steam flows may be measured without the use of a primary element in applications where the Reynolds number is in excess of 10,000,000. Since the line loss produced through a certain length of pipe cannot be predicted as accurately as with an orifice plate, it is a necessity that the meter connected to measure the loss have an adjustable range to accommodate the unpredictable differential that can be established only after start up. Due to its wide range of adjustment, the Hagan Ring Balance meter makes feasible the accurate measure of steam flow using pipe friction as the source of differential. This eliminates the need for installing a very expensive, high-alloy flow nozzle in the steam line. (Item C-2)

MUST HAGAN HIGH QUALITY BE HIGH COST?

Public Utilities have learned that this is not the case. The utilities are bound by law to select new equipment on the basis of competitive price and comparable quality. Here is the score for the last 58 new boiler control systems awarded as a result of this competitive bidding:

	Successful Bids		Successful Bids
HAGAN	19	Company "C"	3
Company "A"	19	Company "D"	2
Company "B"	13	Company "E"	2

(Item C-3)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 702, Pittsburgh 30, Pennsylvania
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If you would like more information on any of the above items, check the appropriate box below.

☐ Item C-1 ☐ Item C-2 ☐ Item C-3

Some Ideas

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One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find – chosen to lighten his work, sharpen his skills. And, if the craftsman is a draftsman, they are, more often than not, products of K&E.

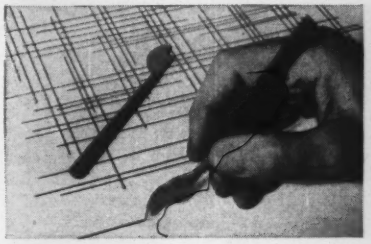
It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new – as well as what's tried and true – in drafting equipment.

You'll find many products like these which can be highly useful in your work . . .

K&E "Quick Set" Bow Compass

The most remarkable feature of this compass is the speed and ease with which you can change settings–from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.



Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large ink supply – draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths, use them as freely as you'd use pencils. They're easy to clean, too.

K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch – or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line* Ruling Pens come in line widths of .030 and .060 inch.

Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.

Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products–small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below . . .

KEUFFEL & ESSER CO., Dept. ME-4, Hoboken, N. J.

I'd like more information on:

- ☐ K&E Quick Set Compass
- ☐ Marathon Ruling Pens
- ☐ Leroy Height and Slant Control Scriber
- ☐ Please send me the name and address of my nearest K&E Dealer.

Name & Title _____

Company & Address _____

1613

THE U.S. TREASURY SALUTES THE AIRCRAFT INDUSTRY

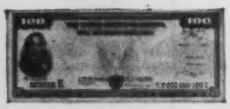
—and its thousands of employees who help strengthen America's Peace Power by buying U.S. Savings Bonds

Men and women who make up the great group who design, fabricate, assemble and test our newest aircraft are also making another substantial contribution to our national security. Many thousands of them are buying U.S. Savings Bonds, regularly, through the Payroll Savings Plan.

Regular purchases of Shares in America help these patriotic and thrift-minded people set up substantial reserves for the education of their children, the buying of new homes and the building of their retirement funds. Through the Payroll Savings Plan the practice of thrift is made easy and automatic.

If your company has not yet put in a Payroll Savings Plan, start now. Your State Savings Bond Director is anxious to help and to show you how easy it is to put the Plan to work. Telephone him now. Or write to Savings Bonds Division, U.S. Treasury Department, Washington, D. C.

L. A. MARTIN, skilled aircraft mechanic, is typical of the thousands of valued employees in this field who are buying U.S. Savings Bonds regularly. Mr. Martin, through his company Payroll Savings Plan, is making a personal contribution to the Peace Power of his country.



MECHANICAL ENGINEERING

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE.

Series 2801 Gate Valve
Illustrated

Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

Vogt

GENERAL GP PURPOSE

Vogt FOR BETTER VALVES

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

FORGED STEEL

VALVES

TO THE MEMBERS OF———

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

O. B. Schier, II, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

Date.....

Please send an application and information regarding ASME to the following:

(1) Name.....
Address.....
.....

(2) Name.....
Address.....
.....

(3) Name.....
Address.....
.....

Member's Name.....
Address.....
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ME-4-59

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

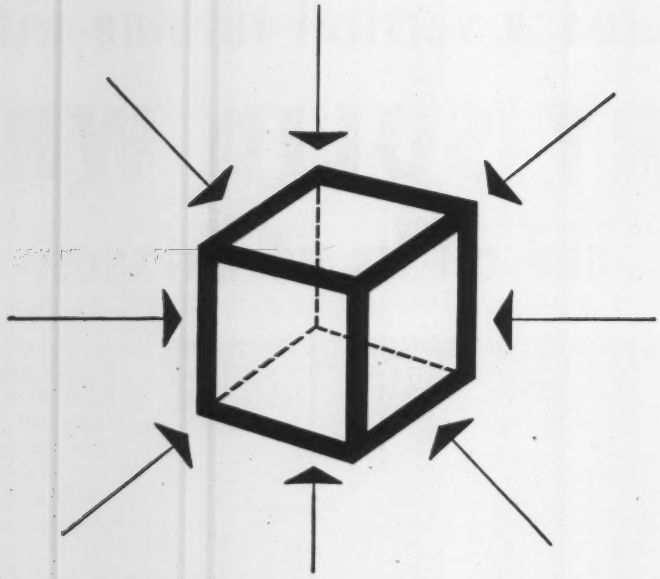
But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



YOU MAY BE JUST THE MAN TO HELP BURROUGHS SQUEEZE A MILLION TRANSISTORS INTO A CUBIC INCH

OR EXPLORE FIELDS LIKE THESE:

- Statistical approaches to physiological processes
- Electro-chemical phenomena
- Radiation effects
- Plasma physics
- Magneto hydro-dynamics
- Electro-luminescence
- Cryogenics
- Superconductivity
- Semi-conductors
- And a lot of others

Right now—today at Burroughs: plenty of room for exceptional engineers to help create the *successors* to Burroughs' big line of advanced electronic and electro-mechanical data processing equipment. Equipment that ranges from giant electronic computer systems to automatic accounting machines and more.

We need men who can help us put the functional equivalent of a million transistors into a cubic inch of material. Or men who can help us produce equally advanced results in fields like those mentioned at the left.

Men who can thrive on working without strait jackets.

Men who can get the most out of our heavily budgeted research facilities.

Men who can welcome the security of our *cohesive* research programs. How cohesive? Because their common aim is to improve information processing for both commercial and military use. How do the programs offer security? Because their cohesiveness allows you to shift readily from one to another without learning a new technology.

We want men whose creativity will help us double our $300 million yearly sales rate fast—and then redouble it even faster.

Men who are frankly interested in increased responsibility. In swift promotion in careers that offer a wide choice of location. And, yes, in money.

Are you as outstanding as these opportunities? Then outline your education and experience as briefly or fully as you wish, name the field you'd like to help us explore, and get that information to A. L. Suzio, Administrator, Corporate Placement Services, Dept. 108, Burroughs Corporation, Detroit 32, Mich.

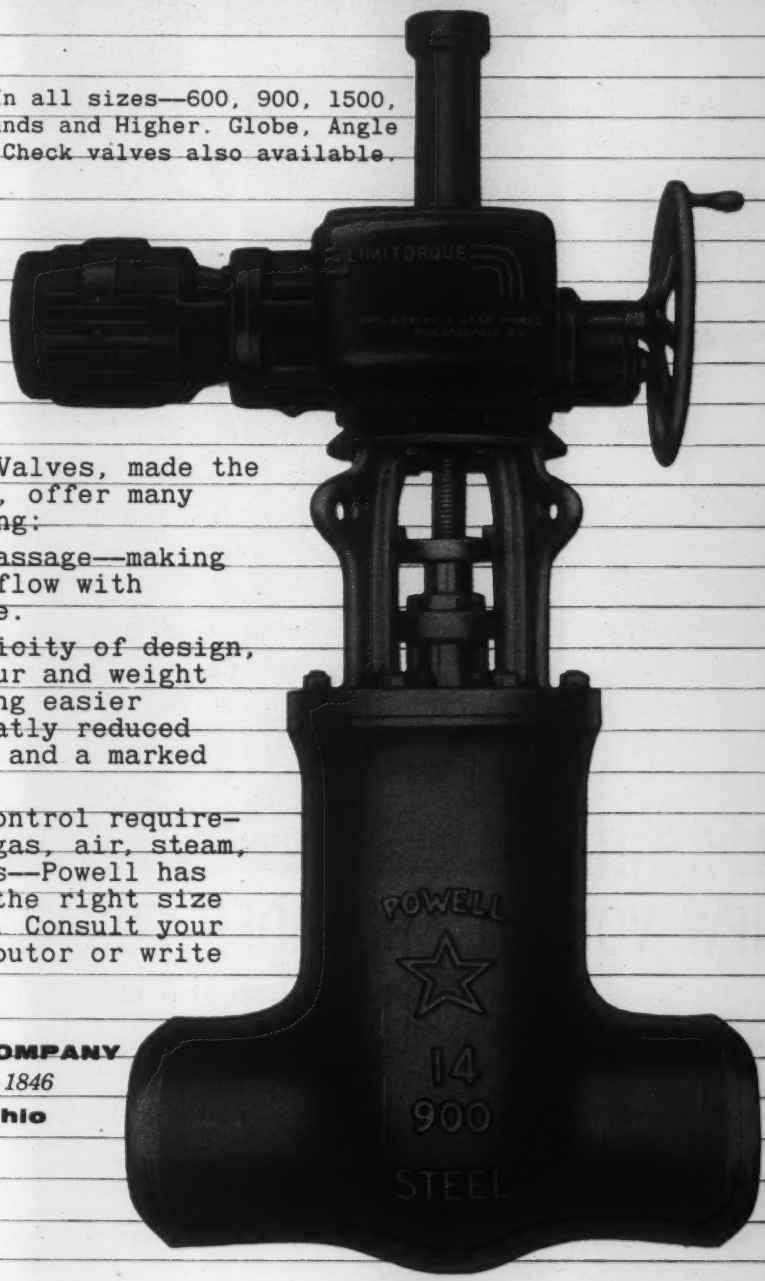
Burroughs

Burroughs Corporation

"NEW DIMENSIONS / IN ELECTRONICS AND DATA PROCESSING SYSTEMS"

Specify POWELL
PRESSURE SEAL GATE VALVES

In all sizes—600, 900, 1500, 2500 Pounds and Higher. Globe, Angle and Check valves also available.



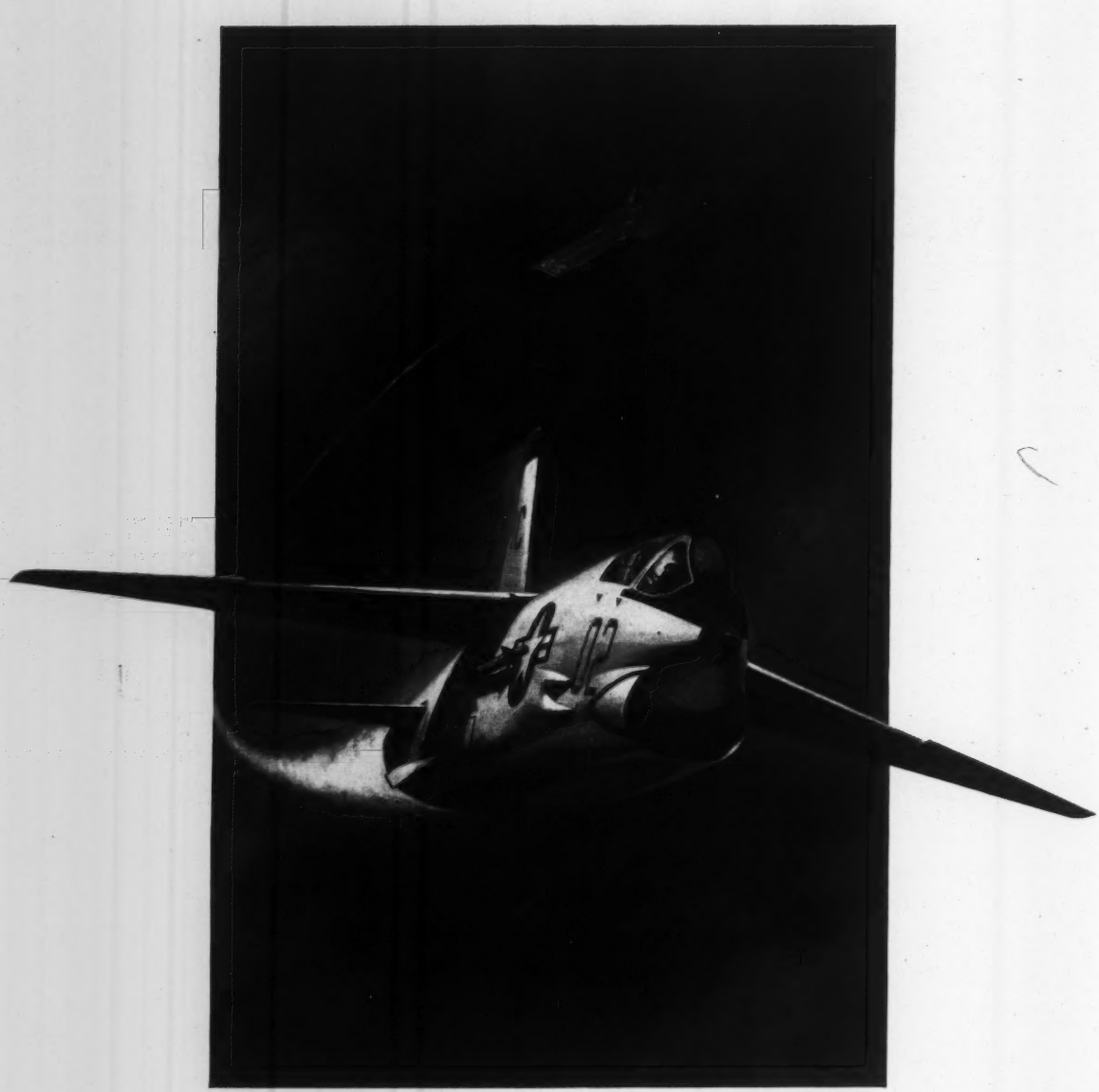
Pressure Seal Gate Valves, made the superior Powell way, offer many advantages—including:

* Streamline flow passage—making possible maximum flow with minimum turbulence.
* Outstanding simplicity of design, smooth body contour and weight reduction—assuring easier installation, greatly reduced insulating costs, and a marked saving in space.

For all your flow control requirements—water, oil, gas, air, steam, and corrosive fluids—Powell has the right valve in the right size and the right metal. Consult your local Powell distributor or write directly to us.

THE WM. POWELL COMPANY
Dependable Valves since 1846
Cincinnati 22, Ohio

POWELL...world's largest family of valves



NEW VOUGHT CRUSADER FOR FLEET NEXT YEAR!

Navy orders fourth version of flexible, economical fighter

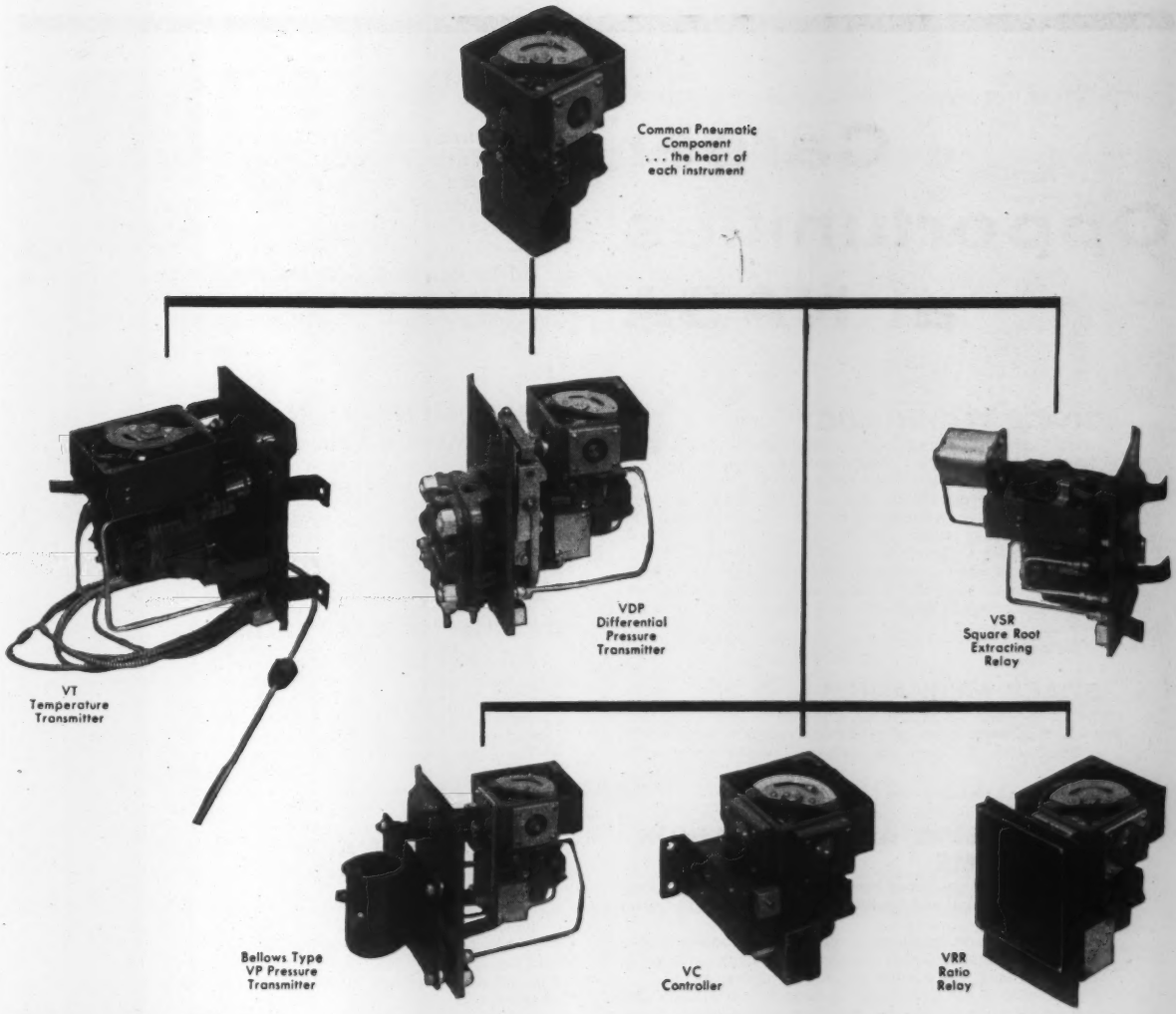
For the fourth time in three years, a new *Crusader* type is extending the power of the Fleet. Chance Vought's F8U-2N has been ordered by the Navy for delivery next year. It will deploy alongside the Navy's swiftest photoplanes and two first line day fighters – all *Crusaders*.

The F8U-2N is another step in *Crusader* growth. Speed of this newest version has been advanced to near Mach 2. It will carry the deadliest air-to-air missiles. It is instrumented and radar-equipped for supersonic combat in darkness or bad weather.

This will be a new capability for the Fleet. Yet it is being acquired at low risk and cost. The F8U-2N's basic design has been proved simple, serviceable and economical . . . compiling an enviable performance record in a year of foreign duty with two Fleets.

Again, the growth provisions of the Vought *Crusader* have provided immediate, low-cost upgrading of the Fleet's aircraft inventory.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS


Common Pneumatic Component . . . the heart of each instrument
VT Temperature Transmitter
VDP Differential Pressure Transmitter
VSR Square Root Extracting Relay
Bellows Type VP Pressure Transmitter
VC Controller
VRR Ratio Relay

Rockwell-Built

Republic Vector Series Instruments

serve any process, cut costs too!

You can save substantial money when your control systems are based on Republic's Null-Balance Vector instruments. Each has as its "heart" an identical pneumatic component, with obvious advantages. Among these are interchange of parts, even among instruments performing entirely different functions. Besides involving a minimum spare parts inventory, this feature greatly simplifies personnel training.

Components shown demonstrate the depth of the Republic line. Differential pressure transmitters with 20-to-1 range adjustment . . . temperature transmitters with 10-to-1 range adjustment . . . pressure transmitters of ±.5% accuracy. We have ratio, totalizing, multiplying, squaring and square root extracting relays. Our all-purpose controllers feature proportional band adjustment of 2% to 500% and reset adjustment from 0.1 to 50 repeats per minute.

The Republic Engineer in your area will be glad to work with you on any control or measurement problem. Sales offices in principal cities throughout the United States and Canada. Call or write—with no obligation, of course.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

Career Opportunities at NASA

NASA directs and implements the Nation's research efforts in aeronautics and the exploration of space for peaceful purposes and the benefit of all mankind. We offer unique opportunities in basic and applied research to scientists and engineers with degrees in the various disciplines.

Briefly described here are representative current NASA programs. Openings exist in all of these programs, at the facilities named.

SPACE TECHNOLOGY

Space vehicle development, including basic planning, development, contract coordination, and operational programming and planning for manned and unmanned satellites. Systems studies for auxiliary power supplies, air regenerative systems, instruments, guidance and communication equipment for space vehicles.

Space probes: Development and operation of vehicles, payload and instrumentation, programming and operation of flight, trajectory, communication systems, and ground support systems for near space and deep space probes.

Beltsville

SPACE MECHANICS

Experimental and analytical study of orbital mechanics including parameters of preliminary and refined orbits, ephemerides, lifetimes, equator crossings and perturbations.

Beltsville; Langley; Ames

PROPULSION AND PROPULSION SYSTEMS

Developmental studies of boosters, launchers, multi-stage engines, guidance and attitude control systems for space vehicles.

Basic research on the interrelationships between electrical, magnetic and thermodynamic energy, and application of such knowledge to space propulsion.

Magneto hydrodynamics: Research on plasma and ion accelerators for space propulsion and auxiliary power systems.

Research on reactors and reactor shielding for aeronautical and space propulsion systems.

Beltsville; Lewis

AERODYNAMICS AND FLUID MECHANICS

Investigation of the thermodynamics and transport properties of gases at high temperatures as encountered in entry into planetary atmosphere.

Research on performance, stability and control, automatic guidance, and navigation for subsonic, supersonic, and hypersonic aircraft.

Aerodynamic heating and satellite re-entry phenomena.

Langley; Ames; Lewis; High-Speed Flight Station

(Positions are filled in accordance with Aeronautical Research Announcement 61B)

INSTRUMENTATION AND COMMUNICATION

Research and development of new sensing devices and instrumentation techniques in electronics, optics, aerodynamics, mechanics, chemistry and atomic physics.

Systems studies and evaluation of control, guidance, navigation, and communication equipment for space vehicles and other high performance applications requiring rugged and compact design.

All Facilities

GEOPHYSICS, ASTRONOMY AND ASTROPHYSICS

Experimental programs and evaluation studies of astronomical and geophysical measurement and scientific equipment used in space vehicle payloads.

Studies of fields and particles in space, investigations of the composition of planetary atmospheres, and development of instrumentation and experimental techniques for these investigations.

Beltsville

STRUCTURES AND MATERIALS

Investigation of the characteristics of high temperature structures and materials. Study of fatigue, structural stability, and other problems of structural dynamics.

Solid State Physics: Study of the elementary physical processes involved in mechanical behavior of materials, such as fractures; the nature of the corrosion process; and physical-chemical relationships governing behavior of materials.

Langley; Ames; Lewis

MATHEMATICS

Application of advanced mathematical techniques to the solution of theoretical problems in aeronautical and space research, involving the use of large modern computing equipment.

All Facilities

RESEARCH FACILITY ENGINEERING

Translation of research specifications into complete experimental facilities, involving mechanical, electrical, structural, architectural and machine design, and construction engineering.

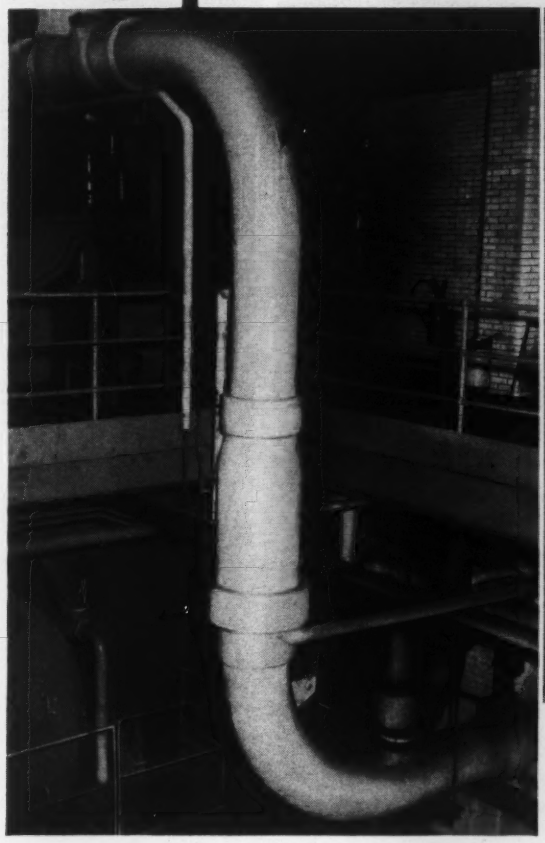
Langley; Ames; Lewis

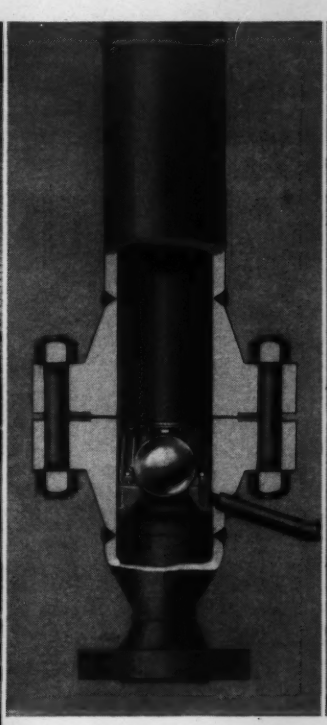
Please address your inquiry concerning any of the programs listed here to the Personnel Director of the appropriate NASA research center:

Langley Research Center, Hampton, Virginia
Ames Research Center, Mountain View, California
Lewis Research Center, Cleveland, Ohio
High-Speed Flight Station, Edwards, California
Beltsville Space Center, 4555 Overlook Ave., Washington, D. C.

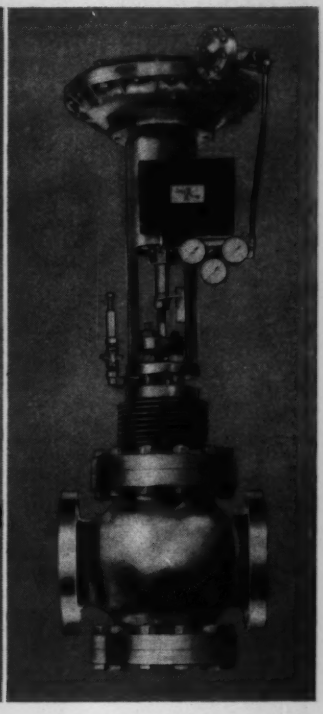
NASA National Aeronautics and Space Administration

How Copes-Vulcan control systems boost power plant efficiency





Steel ball controls orifice opening. Incoming steam lifts the ball in an amount determined by the weight of the ball and the amount of steam flow. Pressure drop of about 3 psig is held constant at all rates of flow.



Copes-Vulcan valve . . . for regulating desuperheater cooling water. Noted for accuracy and dependability, Type CV-D diaphragm-operated valve is available in sizes to 12-inch. Write for Bulletin 1027.

New Copes-Vulcan Desuperheater handles the tough temperature control jobs

Using a unique design principle Copes-Vulcan's newly developed Variable-Orifice Desuperheater* provides superior temperature control demanded on the most critical job. Installed in a steam header supplying a 12,500-kw turbine-generator, this desuperheater holds temperatures within a plus-or-minus 3F limit—even though it is located just 20 feet upstream of the turbine throttle.

With only one outside connection and only one moving part, the Variable-Orifice Desuperheater simplifies maintenance. Skillful design eliminates the need for long runs of piping, atomizing steam, spray nozzle and glands.

The Variable-Orifice Desuperheater is one of several types—each engineered to meet particular operating requirements. Write for Bulletin 1037.

Single source . . . custom design . . . skilled service

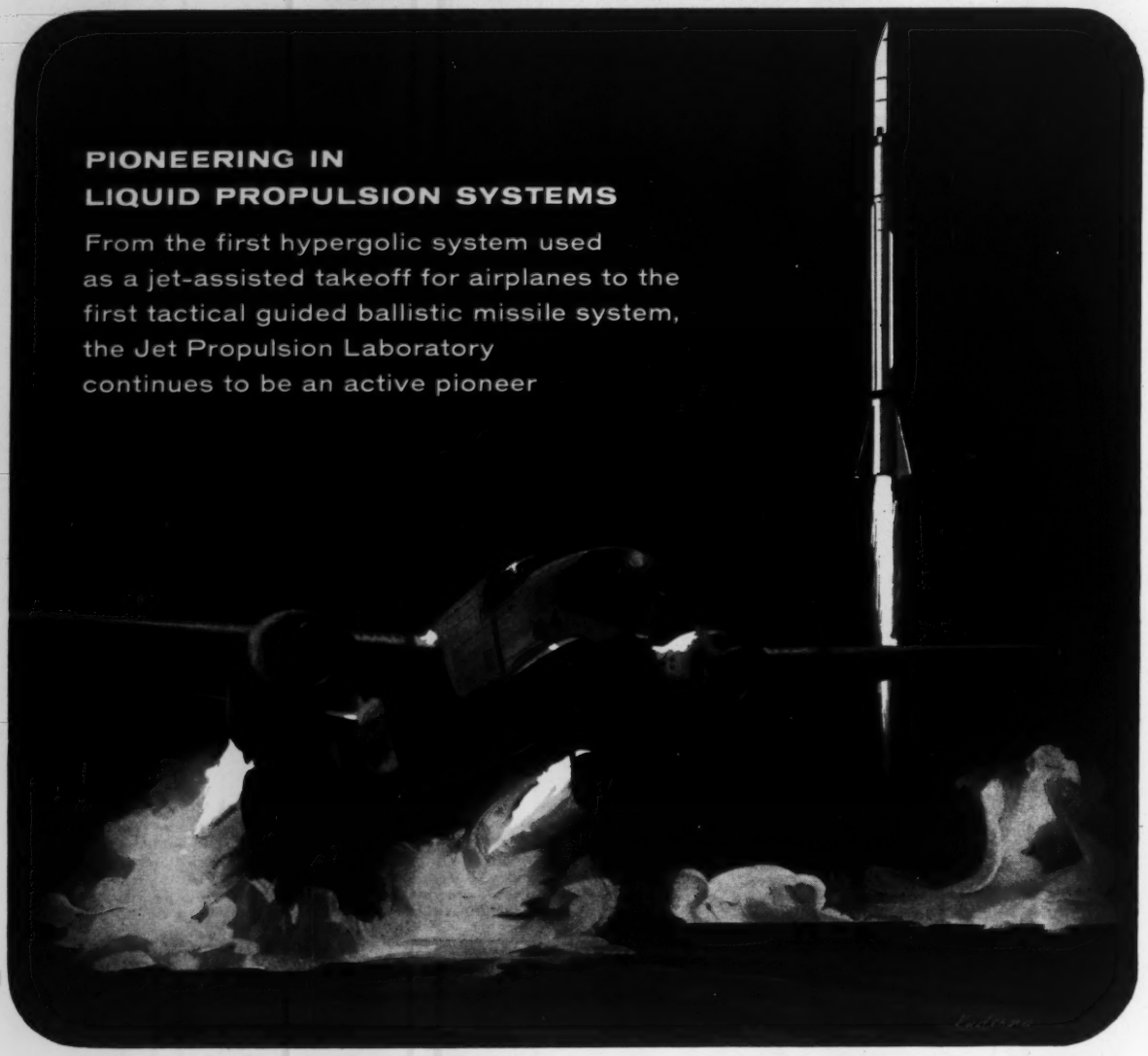
Desuperheaters are a part of Copes-Vulcan's complete line of control systems for superheat and reheat temperatures, feed water, combustion and pressure reducing operations.

Available in separate units or integrated into a single package, these control systems are custom-designed to meet individual specifications, and are serviced periodically by experienced Copes-Vulcan field engineers. For a survey of the line, write for Bulletin 1022-B.

*Patent applied for.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

NOTABLE ACHIEVEMENTS AT JPL...



PIONEERING IN LIQUID PROPULSION SYSTEMS

From the first hypergolic system used as a jet-assisted takeoff for airplanes to the first tactical guided ballistic missile system, the Jet Propulsion Laboratory continues to be an active pioneer

Months before Pearl Harbor, JPL had tested America's first liquid rocket engines using spontaneously igniting propellants. By April 1942, a simple nitric acid-aniline propulsion system was designed into and successfully tested in an A-20-A Bomber for a jet-assisted takeoff. For high-altitude atmosphere research purposes, JPL then used the hypergolic liquid rocket system in the WAC CORPORAL. Placed as a second stage on a V-2 rocket, this became the BUMPER WAC rocket that established a World's altitude record of 242 miles in February 1949.

At the request of U.S. Army Ordnance, the Jet Propulsion Laboratory now began to develop a long-range guided ballistic missile system, incorporating the proven, smooth-burning light-weight acid-aniline system. These achievements sparked the development of a whole series of rocket vehicles. In 1954, the Army accepted the JPL developed CORPORAL, which became America's first tactical guided ballistic missile system; its accuracy exceeded design requirements.

Under the direction of the National Aeronautics and Space Administration, the experienced Jet Propulsion Laboratory research and development team is now working on storable, high-performance hypergolic liquid propulsion systems with which space vehicles may soon orbit the moon and planets.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility of the National Aeronautics and Space Administration

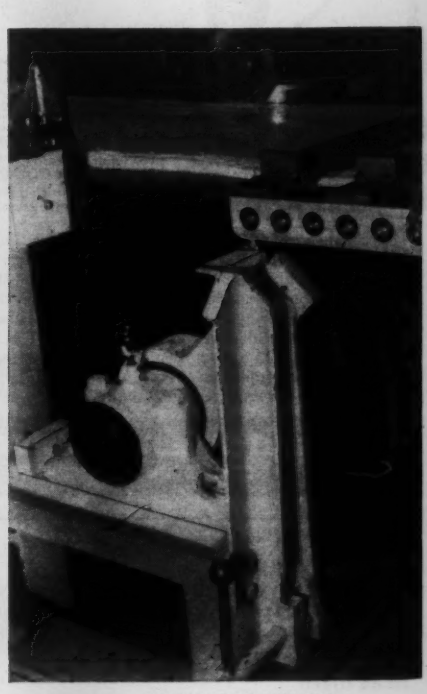
PASADENA, CALIFORNIA

OPPORTUNITIES NOW OPEN IN THESE FIELDS ▶ APPLIED MATHEMATICIANS · PHYSICISTS · SYSTEMS ANALYSTS · CHEMISTS · IBM-704 PROGRAMMERS
ELECTRONIC, MECHANICAL, CHEMICAL, PROPULSION, INSTRUMENTATION, MICROWAVE, AERONAUTICAL AND STRUCTURAL ENGINEERS

Mars, Inc.
maintains product uniformity

with USS **Lorig-Aligner** Self-Centering Rolls

Cooled slab of nougat rides the stainless steel belt to the cutting machinery where it is slit to candy-bar width and cross-cut to length.



MARS uses USS LORIG-ALIGNER Type III Rolls to center stainless steel belt carrying candy slab.

Mars, Inc. produces millions of candy bars a day and USS LORIG-ALIGNER Self-Centering Rolls help maintain uniformity from Bar to Bar.

At Mars, a steady stream of warm candy pours from the mixers onto a 32" wide x 150' long stainless steel belt moving at high speed. At this point, the candy is formed into a continuous slab of nougat that has been accurately sized to a width and thickness. Solidification then takes place as the slab is carried through a refrigerated muffle. As it leaves the delivery end of the muffle and is discharged from the belt, the slab of nougat is slit to candy-bar width and cross-cut to length.

Hour after hour this operation continues, with little variance in size. The answer to such uniform and unerring tracking lies in the USS LORIG-ALIGNER Self-Centering Rolls which carry the belt.

The self-centering action inherent in LORIG-ALIGNER Self-Centering Rolls compels the belt to travel in *exactly* the same path each revolution. Therefore, the slab of candy has no lateral movement because the belt's roll-established center-line does not weave, even though the cambered edges of the belt may show a variation in travel. Such accurate control of belt travel assures increased production and yield, and lowers maintenance costs.

USS LORIG-ALIGNER Self-Centering Rolls eliminate the need for expensive roll-tilting mechanisms and complicated edge-travel sensing devices. There is no belt distortion with LORIG-ALIGNER Rolls because high belt tension is not necessary. USS LORIG-ALIGNER Self-Centering Rolls have many applications, and we will be glad to tell you about them. Just mail the coupon for more information.

USS and "LORIG-ALIGNER" are registered trademarks of United States Steel
"MARS" is a registered trademark of Mars, Inc., Chicago, Ill.

United States Steel
Room 2201, 525 William Penn Place
Pittsburgh 30, Pa.

Please send your booklet, "USS LORIG-ALIGNER Self-Centering Rolls" to:

Name_____

Company_____

Address_____

City_____ **State**_____

(Please Print)

USS

United States Steel Corporation — Pittsburgh
Columbia-Geneva Steel — San Francisco
Tennessee Coal & Iron — Fairfield, Alabama
United States Steel Export Company

United States Steel

SOUTHWEST

"Monoball"

SELF-ALIGNING BEARINGS

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for Engineering Manual No. 551. Address Dept. ME-59.

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

SPECIAL ELECTRIC VARIABLE SPEED HYDRAULIC TRANSMISSION

COST GOVT $350.00

An electric, reversible variable speed transmission. Use where remote or automatically controlled variable speed drive is needed. . . on Lathes, Band Saws, Conveyors, etc. As a Torque Amplifier it will operate a Boat Rudder, Robot Manipulators, etc. As a Servo Motor it will operate large Valves, Ventilators, etc. Each unit is complete with a variable displacement hydraulic pump and motor – both integrally mounted inside oil reservoir. Electric motor is 5/8 HP, 220 V, 60 cycle, 3-phase, 3425 RPM. Remote unit has an electric differential Selsyn motor. Lowest gear reduction is 24 to 1 giving tremendous torque through a 1" output shaft. Delivers 435 inch lbs. of torque at 50 RPM. Also available with a 3/4 HP, 3425 RPM, single phase electric motor at the same prices.

MANUAL CONTROL 138.88 REMOTE CONTROL 148.88

ELECTRIC HYD. MOTOR PUMP AS LOW AS $115

Motor designed to face mount any Aircraft type Hydraulic Pump. Made to meet the most rigid requirements of industry. For continuous duty with a high starting torque. Available in 115/230 V, 1 phase or 220/440 V, 3 phase – 60 cycle AC. Sizes from 3/4 to 15 HP. Pressures up to 3000 PSI. Write for Cat. H-59 for complete information and other Bargains.

21 TO 1 SPEED REDUCER

Precision built for Army Gun Control Mechanism. Gear ratio gives approx. 90 RPM with direct drive 1750 RPM motor. Can be belt driven with up to 1/2 HP motor. Has ball bearings throughout. Will operate conveyors, timing devices, etc. 21 to 1 gear ratio. 14.75

NOTE: Many other gear Bargains in stock. Write for Catalog Supplement H-59.

GRAVITY CONVEYOR

Has 500 lb. per ft. capacity. 12" wide curved steel frame with guard rail. 5 rows of 2" dia., 5/8" face ball bearing steel wheels. Unit is 45° ACR on 35" center line radius. Each unit couples to next at ends. Unused, excellent condition. 14.95 EA.

HYDRAULIC REMOTE CONTROL MASTER & SLAVE

When connected with 1/4" tubing these units act as a precision, remote power transmission unit. Moving master handle causes the slave arm to respond in exact ratio to the master. Ideal for remote machinery controls. Both units (used) No. H-EX-15U 27.50

SAVE up to 85% on HYDRAULIC Valves, Pumps, Cylinders, Motors, etc.
We have the Largest On-the-shelf stocks in the country. Write for Cat. H-59

Palley's

Pay by M.O. or Check. P.O.'s accptd. from D&B firms ½ dep. with C.O.D.s Prices F.O.B. Los Angeles.

2263 E. Vernon Ave., Dept. ME-49, Los Angeles, Calif

VOSS VALVES in your machine mean

LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

• up to 40% more valve area • minimum pressure loss • higher efficiency • less power consumption • normal discharge temperature • quiet, vibration-free • utmost safety • lower operating costs

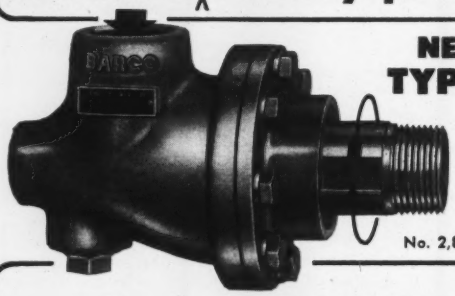
VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machine (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

VOSS VALVES J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

Better

Need a rotary joint?



NEW TYPE C

Patent No. 2,836,439

-it's BARCO!

For countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had—*and for LESS COST!*

"CRACK-FREE" CHROME PLATED SLEEVE—A standard Barco feature. Minimizes corrosion, friction, wear. Stainless steel spring also standard.

RESISTS SEAL RING BREAKAGE—The spherical seal ring is under compression, not *tension*, loading. Self-adjusting for wear. Seal withstands shock loads and alternating hot and cold service.

WIDE SPACED BEARINGS—Two, instead of one . . . increased bearing area. No lubrication required. Lowest friction.

200 P. S. I. STEAM RATING—Heavy duty service at *no extra cost.* Eight sizes, ½" to 3". *Send for new Catalog 310 today.* **BARCO MANUFACTURING CO., 521E Hough Street, Barrington, Illinois.**

Aerovent builds 'em BIG!

"WE BUILD THE FANS TO FIT YOUR PLANS!"

Yes . . . in Duct Fans, as in all types of air-moving equipment, Aerovent offers a size for every standard industrial installation (and special applications to order).

Illustrated above is a huge 84" Duct Fan . . . one of 24 built by Aerovent for The Consolidated Edison Company for installation in its Arthur Kill and Astoria Generating Stations. These fans, with 20 H.P. motors turning 580 RPM, move air against resistance at the rate of 100,000 CFM. Other Aerovent units are available in sizes from 12" to 96" for capacities to 145,000 CFM.

Aerovent Duct Fans . . . direct-driven for standard applications or belt-driven for conditions requiring motor outside airstream . . . may be ordered with special duty motors, alloy propellers and special protective coatings for extreme temperature, moisture or corrosive conditions.

WRITE FOR FREE BULLETIN No. 151

DUCT FANS FOR ALL INDUSTRIAL REQUIREMENTS

Direct-Driven Duct For installations which permit connection of entire fan assembly in air-stream. For vertical or horizontal use. 12" to 96".

Belt-Driven Duct Used for corrosive or high-temperature conditions, which require motor to be outside airstream. 2, 4, 6 or 7 blades. 12" to 96".

"Bi-Flo" Duct For pressures in the 1½" to 4½" range. New 7-blade "Machete" Airfoil Propellers move more air with lower horsepower. 18" to 48".

"EFFICIENCY-ENGINEERED" equipment for every air-handling problem!

Aerovent

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Certified Ratings

Aerovent FAN CO. INC.

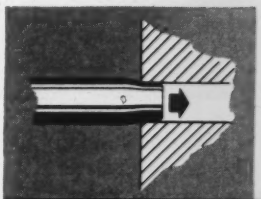
Ash and Beach Sts. Piqua, Ohio

SPIROL - the spring PIN with PERFECT CHAMFER

For Smoother Insertion!

A. Smoothly rounded radius where chamfer meets shank eases insertion into hole. No sharp break to "bite" and resist insertion. B. Chamfer angle is precisely designed to offer minimum thrust resistance and maximum compression leverage.

OTHER UNIQUE SPIROL FEATURES

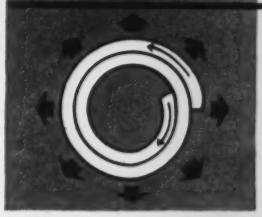


WIDER HOLE TOLERANCES

Both plus *and* minus hole tolerances are allowed because spiral construction permits greater flexibility in expansion and compression. The wider hole tolerances eliminate precision reaming requirements, reduce drilling rejects, cut costs.

MINIATURE PINS

SPIROL is the only spring type pin available in these miniature diameters: 1/32" — .039" — 3/64" — .052". Unique spiral cross-section retains flexibility and strength in smallest sizes. Other standard sizes up to ½" diameter.



SHOCK RESISTANCE

High resistance to shock and vibration permits use of "medium duty" SPIROL pins in a wide variety of materials with wide range of bearing loads. Heavy and light duty SPIROL pins also available in stock.

NON-HEAT-TREATED METALS can be specified in standard SPIROL pins for extra corrosion-resistance or conductivity. Less resilient metals are usable because stress is evenly distributed throughout the spiral cross-section, giving maximum spring action.

FREE! *Write for literature on Spirol Pins.*

SPIROL PIN

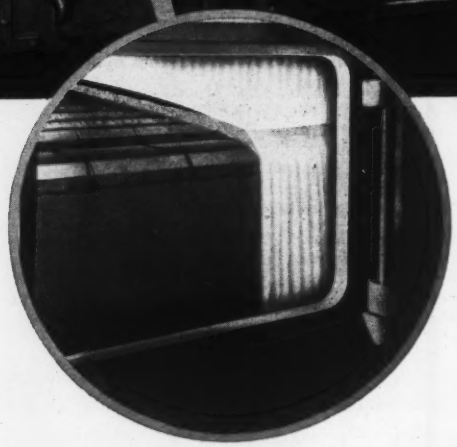
C. E. M. COMPANY • 130 SCHOOL ST. • DANIELSON, CONN.

A STANDOUT UNDER ANY TEST

DETROIT ROTOSTOKER C-C (Continuous Cleaning)

In any test you want to apply DETROIT ROTOSTOKER C-C *(Continuous Cleaning)* **will stand out**

Detroit RotoStoker C-C (Continuous Cleaning) with reciprocating grates that continuously clean the fire and discharge ash at the front, where it may be taken from the ash pit at floor level if desired, avoiding need for a basement ash bunker. High sustained efficiency, high availability low power for operation — For boiler capacities from 5,000 to 75,000 pounds steam per hour.



Efficiency, availability, flexibility under fluctuating load, ability to burn good or low grade coals or waste materials, durability, low parasite power consumption and low maintenance. RotoStoker C-C scores high on all points.

Among those who have tested the RotoStoker C-C — found it a winner — are such well known names as:

Allied Chemical & Dye Corporation
Alpena Power Company
American Cyanamid Company
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The Electric Auto-Lite Company
Automatic Electric Company
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Columbian Carbon Company
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General Tire & Rubber Company
Manchester Board and Paper Company, Inc.
National Gypsum Company
Newberry State (Mich.) Hospital
Pittsburgh Steamship Company
U. S. Dept. of Defense
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RotoStoker C-C is typical of the Dependable Detroit Line which includes stokers for efficient firing of boilers from 3,000 to 400,000 pounds per hour steam capacity.

DETROIT STOKERS COST LESS: COST EQUALS INITIAL INVESTMENT PLUS UPKEEP PLUS PRODUCTION LOSSES DUE TO EQUIPMENT OUTAGE. THE TOTAL IS LESS WITH DETROIT.

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MAIN OFFICE AND WORKS • MONROE, MICHIGAN
District Offices or Representatives in Principal Cities

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positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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Experienced creative engineers with advanced degrees in Mechanical Engineering, Mechanics, or Metallurgy and at least five years of experience are invited to inquire about positions. A good knowledge of applied mathematics and the fundaments of applied mechanics is required. Diversified experience is welcome.

We are a small R&D group with a reputable heavy machinery manufacturer entering into a vigorous product diversification program. We are the leading division of a national corporation. We are and will be conducting a wide range of fundamental and applied investigations in mechanical and metallurgical fields. If you seek association with a progressive minded company, send your resume to:

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ME's or IE's with 3 to 5 years of Time Study and standards experience.

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EE or ME with some QC experience and supervisory background in electro-mechanical equipment.

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MECHANICAL ENGINEERS

ME's with 3 to 8 years' experience in development of engineering standards and/or product engineering.

ME's with 2 to 6 years' production engineering experience in electro-mechanical equipment field.

Kindly send resume and salary requirements to:

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B.S. OR M.S.

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Excellent opportunity for man with 5 to 10 years' chemical or petroleum plant experience, specializing in installation, operation and maintenance of wide variety of pumps and seals.

Will provide consulting aid to plants and divisional engineers in the selection, specification, maintenance and standardization of pumps, and will develop new and improved pump practices.

Please provide details of prior experience in letter. Salary open.

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TWO INSTRUCTORS for instrumentation courses in training school conducted by long-established, major instrument-manufacturer. Previous teaching experience desirable, with degree in physics or electrical, mechanical, or chemical engineering. Duties include organizing and conducting one-week to three-month courses, repeated several times yearly, for field-engineering trainees of company and for customers' instrument-technicians. Subject matter covers operating principles, construction, installation, and maintenance of indicators, recorders, controllers, and telemetering equipment for pressure, temperature, flow, liquid-level, etc.; self-balancing potentiometers and bridges; pneumatic and electric valves; etc. These are new jobs created because of steadily increasing demand for company's products and services. Salary is open and will be made definitely attractive to the right men. Write C. F. Johnson, Manager Education, The Bristol Company, Waterbury 20, Connecticut.

Engineers

R&D OPPORTUNITIES in CALIFORNIA with SYLVANIA

MECHANICAL TUBE ENGINEERS

Perform mechanical design & test of tubes, components and tooling. 5 years' experience in mechanical design, testing & evaluating special purpose tubes.

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Electromechanical design of electronic equipment. Background in microwave systems & antennas desirable.

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Packaging of airborne electronic subminiaturized equipment. 7 or more years' experience in electromechanical packaging of electronic equipment desired.

Please send resume to
Mr. Wayne Pearson

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SYLVANIA ELECTRIC PRODUCTS INC.

P.O. Box 188
Mountain View, California
On the San Francisco Bay peninsula

ENGINEERS

Celanese has challenging opportunities in the Fibers Division Development and Process Laboratories located in Charlotte, N.C. for graduate engineers with the following qualifications:

MECHANICAL ENGINEER

B.S. or M.S. with up to 5 years in synthetic fiber or related industries. Principal assignments cover problems in Pilot Laboratories of Development Section concerned with translating development ideas into practical mechanical processes. Assignments necessitate frequent contacts with Merchandising, Sales, Manufacturing, and Technical Departments.

PROJECT ENGINEER

B. S. or M. S. in Mechanical or Chemical Engineering with 3-5 years experience in synthetic fiber processing or allied industries; to provide mechanical design service and execute projects in the application and product development area, which relate to yarn and fabric development requirememnts.

Liberal Company Benefits, excellent opportunities for advancement and ideal working conditions. Complete résumé should be addressed to

R. V. Butts, Regional Personnel Manager
CELANESE CORPORATION OF AMERICA
P. O. Box 1414
Charlotte 1, N. C.

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

what's a BABE?*

...or a SHAKE?*

.... or a zerk?* or a jerk?*

These words are part of the scientific shorthand used at Los Alamos, where rapid advancement in nuclear research constantly requires new symbols. The Los Alamos Scientific Laboratory has openings for scientists and engineers interested in such fields as thermonuclear power, experimental fission reactors, nuclear rocket propulsion.

*Babe = 20 KEV Shake = 10^{-8} sec.

Jerk = 10^{16} ergs Zerk = 10^{25} ergs

Write to:
Personnel Director
Division 59-36
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scientific laboratory
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Highly Creative Engineer . . .

for challenging work in the design of systems and equipment in the food processing field. Thorough grasp of engineering fundamentals and experimental procedures necessary. BSME or BS ChE with five years' experience.

Research Mechanical Engineers . . .

to design food processing equipment or packaging machinery. Top level BSME's with sound background in engineering fundamentals. Experience desirable.

- career opportunity
- relocation allowance
- extensive benefit program

Send complete resume to:

General Mills

Personnel, Room G
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For central engineering department of large manufacturing plant. Men preferred with experience in pulp, paper or hardboard industry. Work involves general engineering, power plant, piping layouts, automatic product handling, processing equipment design and board work. Excellent opportunity for men of exceptional ability. Should have engineering degree or equivalent. Give complete information including salary range with application. Our employees know of this advertisement. Location South.

Address CA-6644, care of "Mechanical Engineering."

THE MOST INTERESTING OPPORTUNITY OF A LIFETIME FOR A *YOUNG-AT-HEART* ENGINEER

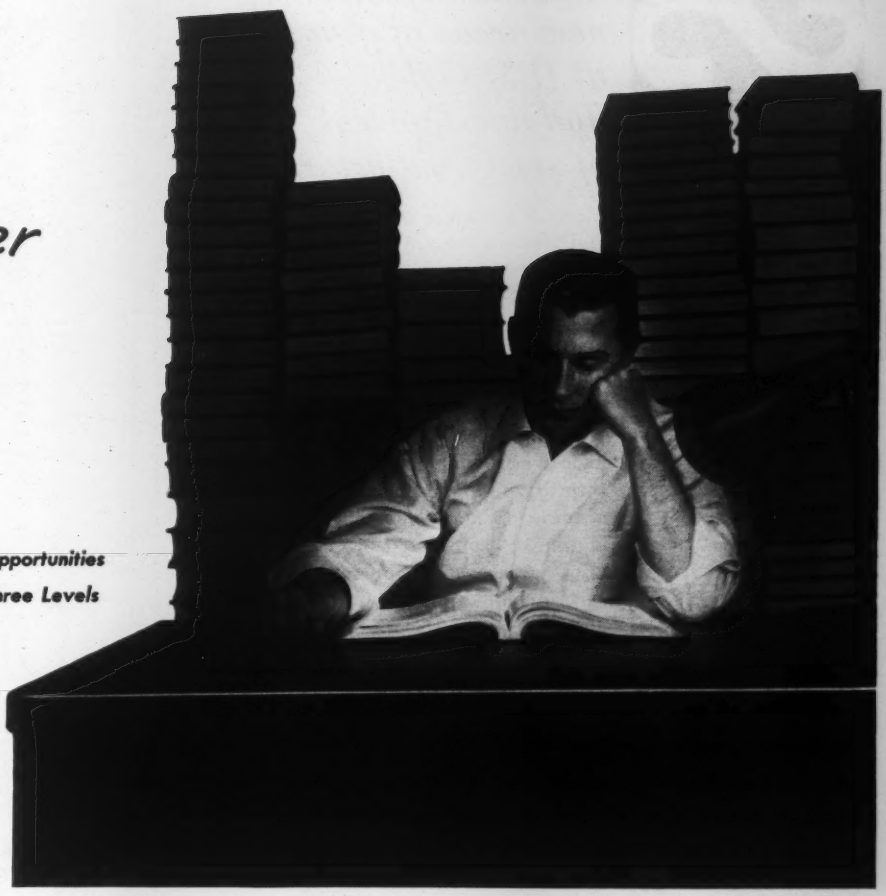
Do you believe in encouraging high school students to study science? In order to promote that encouragement, courses of study in science as applied to industry are in the planning stage in a new parochial high school building which is just now being completed in Southeastern Pennsylvania. The courses are intended to supplement the formal science curriculum such as biology, chemistry and physics. Local industry is supporting and sponsoring the courses.

An engineer with considerable practical experience, possibly retired from industry, is being sought to set up, and teach the courses. The successful candidate should have a broad understanding of scientific principles as applied to industrial practices. The desire to work with intelligent young people and see them develop can readily be fulfilled in this capacity.

Since the courses are sponsored by industry, the salary is open, dependent upon the capabilities of the successful candidate. Applications will be held confidential if requested. Send your complete resume to

CA-6649, care of "Mechanical Engineering."

How far can an engineer go at AC?



Special Advanced Education Opportunities Develop Career Potential on Three Levels

If you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics, you can work on AC's famous AChiever inertial guidance system or a wide variety of other electro-mechanical, optical and infra-red devices. You can also prepare for promotion and enhance your professional status through AC's free comprehensive training programs—the finest "in house" programs available.

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms. You attend classes three hours per day for four months, all on company time.

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These thoroughly practical courses—taught by university professors or recognized AC specialists—constitute AC educational "extras." AC offers them in addition to their educational assistance programs for men who wish to study for advanced degrees in nearby universities.

AC invites you to compare these advanced training offerings with those of any other company. Get complete details today. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. F, Box 746, South Milwaukee, Wisconsin.

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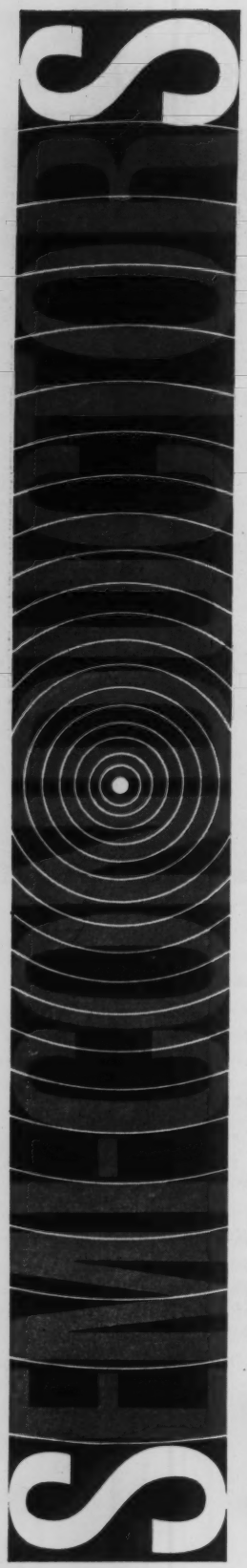
AC SPARK PLUG
THE ELECTRONICS DIVISION
OF GENERAL MOTORS



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Many new designs in IBM circuits and systems require the latest advances in the semi-conductor field. IBM's program includes theoretical and experimental studies in the most advanced semi-conductor devices and technology. An example of original IBM development is the NPN high-speed drift transistor for logical switching and high-power core driving. These programs are opening up new opportunities for high-level professional people. Related areas where opportunities exist include: applied mathematics and statistics, circuit research, logic, cryogenics, optics, phosphors, magnetics, microwaves, theory of solid-state, transistor design.

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Analyze mechanical systems for vibratory behavior under enviromental conditions, beginning with theoretic analysis of initial system design concepts through final experimental prototype units. Responsible for experimental investigations, conduct corrective system re-design liaison, pioneer and formulate vibratory measurement techniques including random vibration testing.

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Requires aptitude for analytical work in one or more of the following fields: Aerodynamics, thermodynamics, heat transfer, hydraulic and fluid dynamics and servomechanism analysis. Encompasses both applied theoretical and experimental analysis associated with design and development of turbo-props, jet aircraft equipment and missile components. Position involves performance computations, defining configurations of product components and complete systems to meet specifications, conducting system dynamic control analysis to insure proper stability and response characteristics. Advanced digital and analog computers available to permit application of complex methods of analysis.

Join a technical group whose facilities and background knowledge are unrivalled in the industry. Your talents will be employed in the development of advanced concepts, and also in internal consulting work on problems encountered by the Design and Development Engineering Groups.

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Mr. A. J. Fehlber
Technical Employment Supervisor

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DIV. OF UNITED AIRCRAFT CORP.
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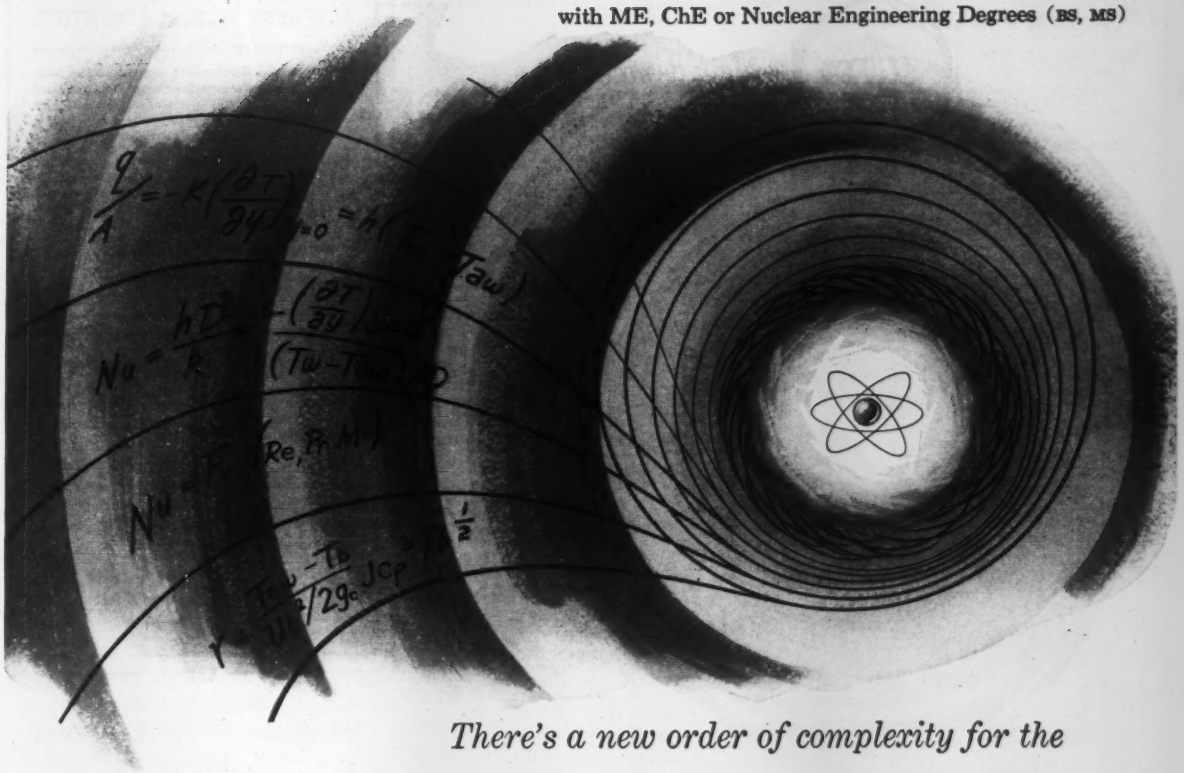
Windsor Locks, Connecticut

THERMODYNAMICISTS
with ME, ChE or Nuclear Engineering Degrees (BS, MS)



There's a new order of complexity for the

Thermodynamicist

in developing the nuclear propulsion system for aircraft

The requirements for small-size, coupled with high-power density in a reactor for flight propulsion, raise problems in heat transfer never faced before.

As an indication of the technical difficulty of these problems, consider the fact that the reactor now being developed by General Electric for flight propulsion must generate more power than a submarine reactor, though it is only a fraction of the size.

If problems "of this order" attract you, and you have had 3 to 8 years relative experience, your inquiry on any of the following assignments will be welcomed:

- EXPERIMENTAL FLUID DYNAMICS & THERMODYNAMICS ANALYSIS OF REACTOR PERFORMANCE.
- HEAT TRANSFER AND FLUID FLOW DESIGN CALCULATIONS FOR NUCLEAR REACTORS.
- CALCULATIONS ON NUCLEAR DESIGN PARAMETERS OF EXISTING OR PROPOSED REACTOR COMPONENTS AS BASIS FOR CRITICAL EVALUATION.
- DEVELOPMENT TESTING OF HEAT TRANSFER & FLUID FLOW DESIGN OF REACTOR COMPONENTS.
- DEVELOPMENT TESTING OF REACTOR CORE COMPONENTS.
- MECHANICAL DEVELOPMENT OF POWER PLANT COMPONENTS. ALSO OF REACTOR STRUCTURAL COMPONENTS. *(Includes devising and conducting laboratory tests.)*

Assignments are at several levels

Write in confidence, including salary requirement.
Mr. P. W. Christos, Div. 41-MD
AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

GENERAL ELECTRIC

P.O. Box 132 CINCINNATI 15, OHIO

New dimensions in Communications

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GENERAL TELEPHONE LABORATORIES is currently engaged in a long-range program of research aimed at increasing the efficiency and versatility of the telephone system as a basic communications network.

Promising techniques now under investigation include time-division multiplexing, pulse-code modulation, pulse switching and high-speed electronic switching and gating.

Our explorations in time will ultimately lead to a super-communications system capable of accepting and directing numerous modes of transmission in less time.

This is but one phase of our work in providing research and design support for Automatic Electric and other affiliated manufacturing units of the General Telephone System.

We are interested in engaging the services of a limited number of Physicists, Electrical Engineers and Mechanical Engineers with experience and interest in Logical Circuit and System Design, Memory Devices, High-Frequency Pulse Techniques, Electronic Switching, Component Packaging and Electro-mechanical Design. If you can read yourself into any of these projects, write in confidence to Mr. Robert Wopat, President, General Telephone Laboratories, 200 Wolf Rd., Northlake, Illinois.

General Telephone Laboratories

GENERAL SYSTEM

SOUTHERN RESEARCH INSTITUTE

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Mechanical Engineers to work in the field of high-temperature thermal properties of materials. Experience in the design and operation of high-temperature furnaces and a knowledge of heat transfer are desirable.

Metallurgists at various levels of experience needed for responsible positions in research on alloy development, high-temperature metallurgy, process development, and structural properties of materials.

Please send resume to

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Good future prospects to Graduate M.E. desiring to advance with experience. Prefer man with military service completed and some industrial experience in design, estimating, specifications and layout for plant improvement and development. Send complete resume including salary requirements in confidence to

G. R. Taylor, Chief Engineer,
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Fulton, New York

SENIOR AND JUNIOR MECHANICAL DEVELOPMENT ENGINEERS

One Senior Mechanical Development Engineer with advanced technical education in mechanical engineering and applied mechanics with ten to twenty years' experience in design and development of heavy machinery. Permanent position with well established heavy machinery builder to the steel and allied industry. Salary $12,000 to $15,000 per year. Also, one Junior Mechanical and Development Engineer, similar training, five to ten years' experience, salary $9,000 to $12,000 per year. Location Pittsburgh.

Address CA-6614, care of "Mechanical Engineering."

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Well established machinery manufacturer has need of a sales executive to direct sales functions and customer relations, and to participate in related matters such as product development and pricing. Best experience would be in shoe machinery or shoe manufacturing as Works Manager or Sales Manager, with past sales engineering experience. Must be engineering and cost minded, able to analyze customer requirements and cost improvements. Background in comparable high production machinery also considered. Engineering or accounting training desired. Excellent growth potential. Age 40–45. Substantial salary, bonus, and stock option plan. Your reply invited in complete confidence.

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ROOM AIR CONDITIONERS—wall and window mounted

PACKAGED AIR CONDITIONERS—3-30 hp.

are urgently needed to augment an experienced engineering staff now being expanded to handle a rapidly growing product line and a vigorous market. Specific types of experience required include:

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Excellent working conditions. Liberal employee benefits. Forward resume of experience to Airtemp Division—Chrysler Corporation, P. O. Box 1037, Dayton 1, Ohio.

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Sought by manufacturer of boiler accessories. Job requires experience in engineering supervision and equipment testing, also with machine tools, gearing, automatic machinery, and stress analysis. Your enthusiasm and ambition will make your future.

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ELECTRICAL, INDUSTRIAL, MECHANICAL ENGINEERS needed for undergraduate and graduate teaching at off-campus centers in Birmingham and Huntsville, Alabama. Rank of Associate Professor or Professor, salary up to $8,000 for nine months, plus up to $2,000 for summer term. Part-time research and consulting work with industry will provide an additional $2,000 per year. Persons with Doctor's Degree preferred. Direct inquiries to: Director, Engrg. Extension, Box 2987, University, Alabama.

OPPORTUNITY: Supervisor for development and operation of mechanical laboratory. Also to teach Fluid Flow and Heat Transfer. Opportunity for professional growth and contribution. Least required: M.S. degree and supporting experience. 12 month contracts with leave time each year. Contact H. B. Ratcliff, Head of Department of Mechanical Engineering, Bradley University, Peoria, Illinois.

POSITION AVAILABLE for teaching undergraduate and graduate courses in fluid mechanics, heat transfer, and directing thesis research. Only applicants with Ph.D. degree considered. Salary compatible with qualifications. Write to Head, Dept. of Mechanical Engineering, Univ. of Kentucky, Lexington, Ky.

TRANSLATORS. Proven ability to translate technical material into fluent English essential. Attractive full time or free-lance arrangement. All languages of interest, particularly Russian. Send resume to: A.T.S., Inc., Drawer 271, East Orange, N.J.

ASSOCIATE and ASSISTANT PROFESSORS for fields of advanced dynamics, advanced strength, and elasticity. Also have opening for graduate student as half-time instructor. Engineering Mechanics Dept., Kansas University, Lawrence, Kansas.

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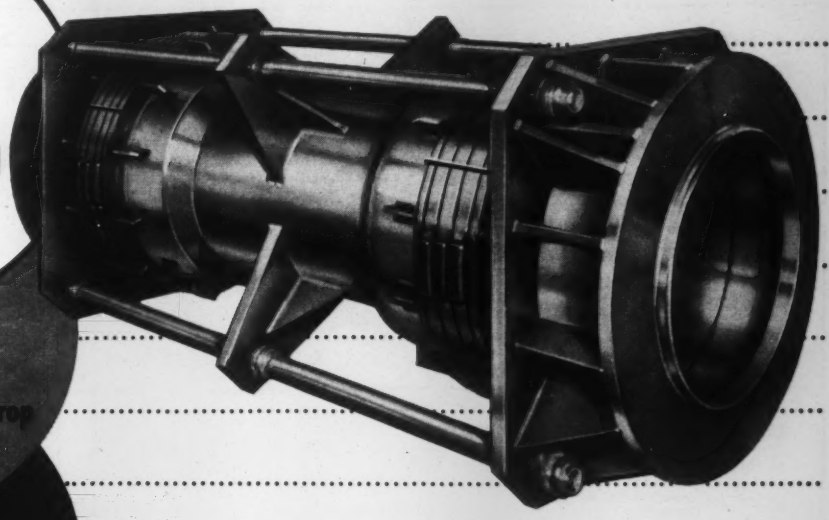

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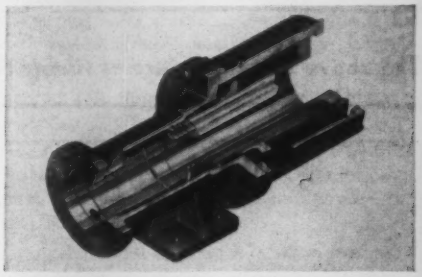

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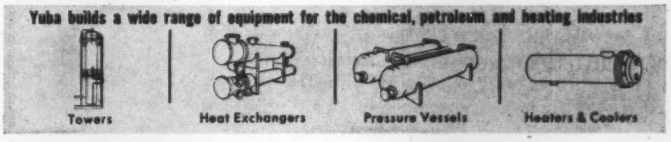

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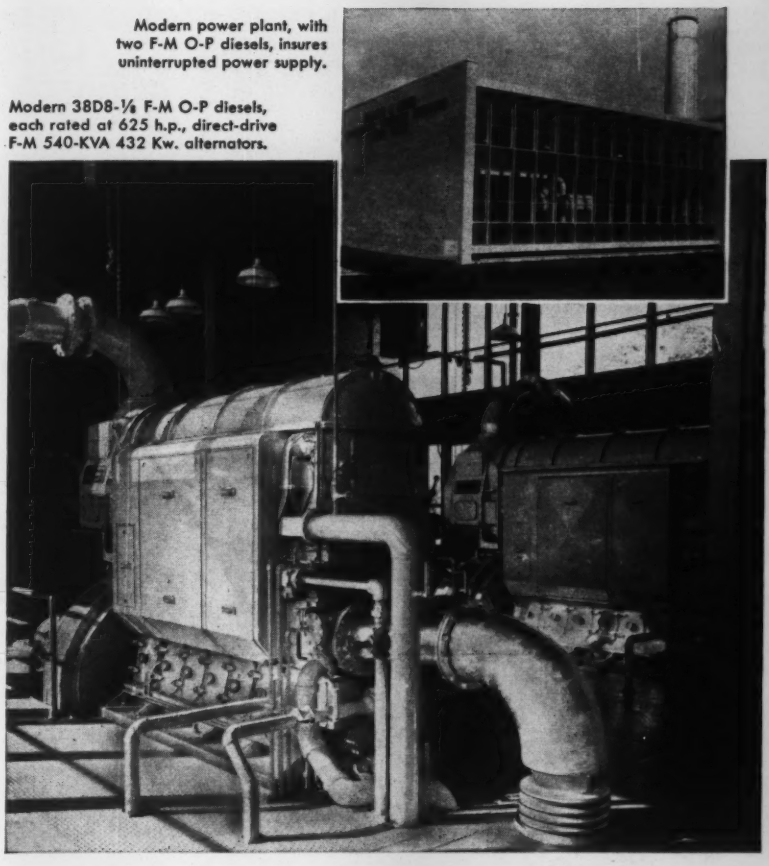

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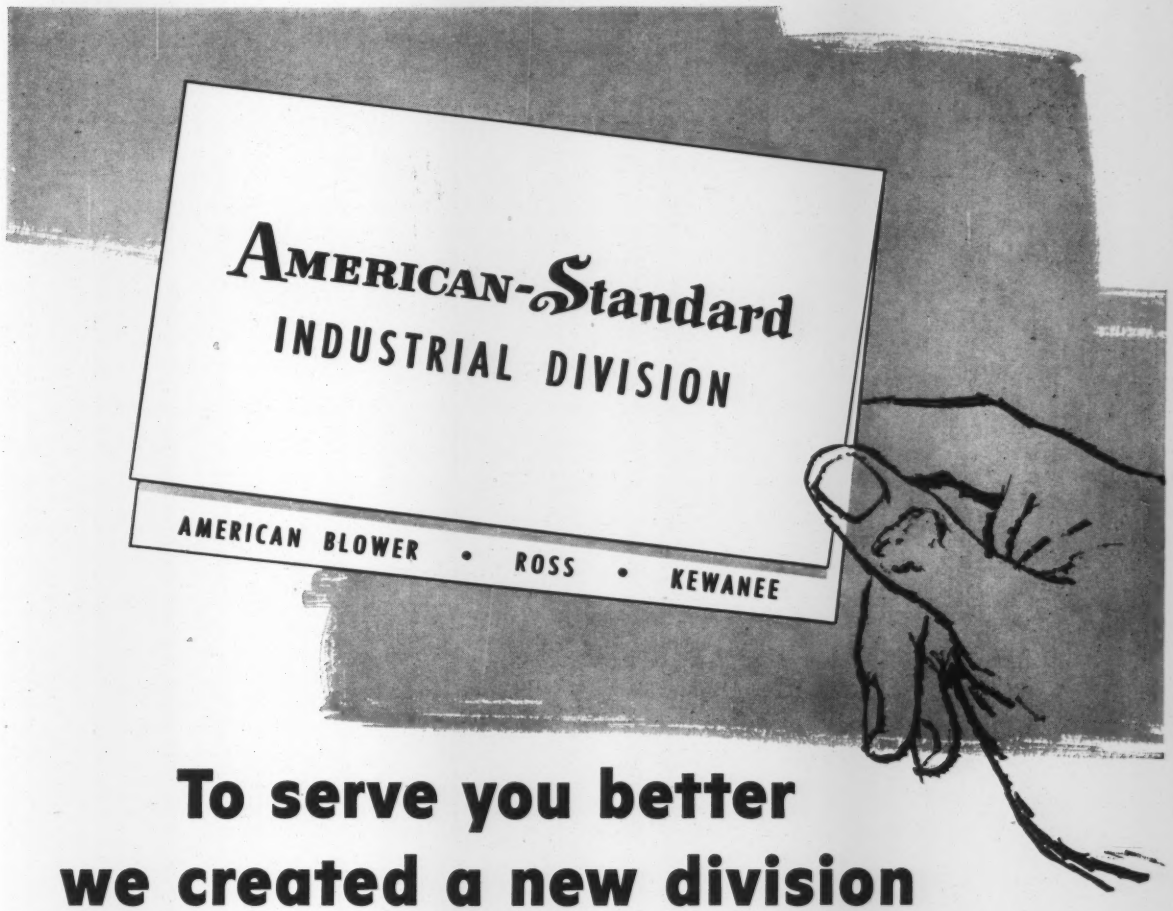

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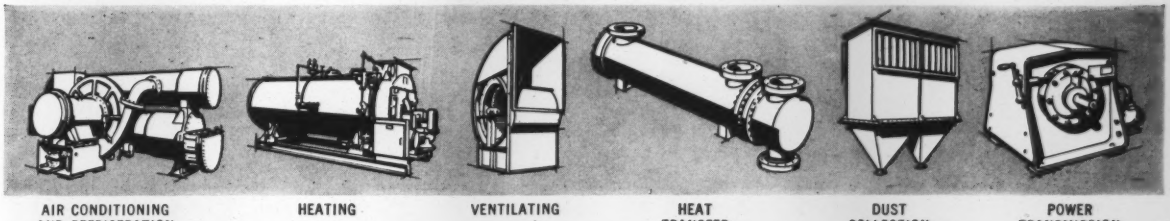

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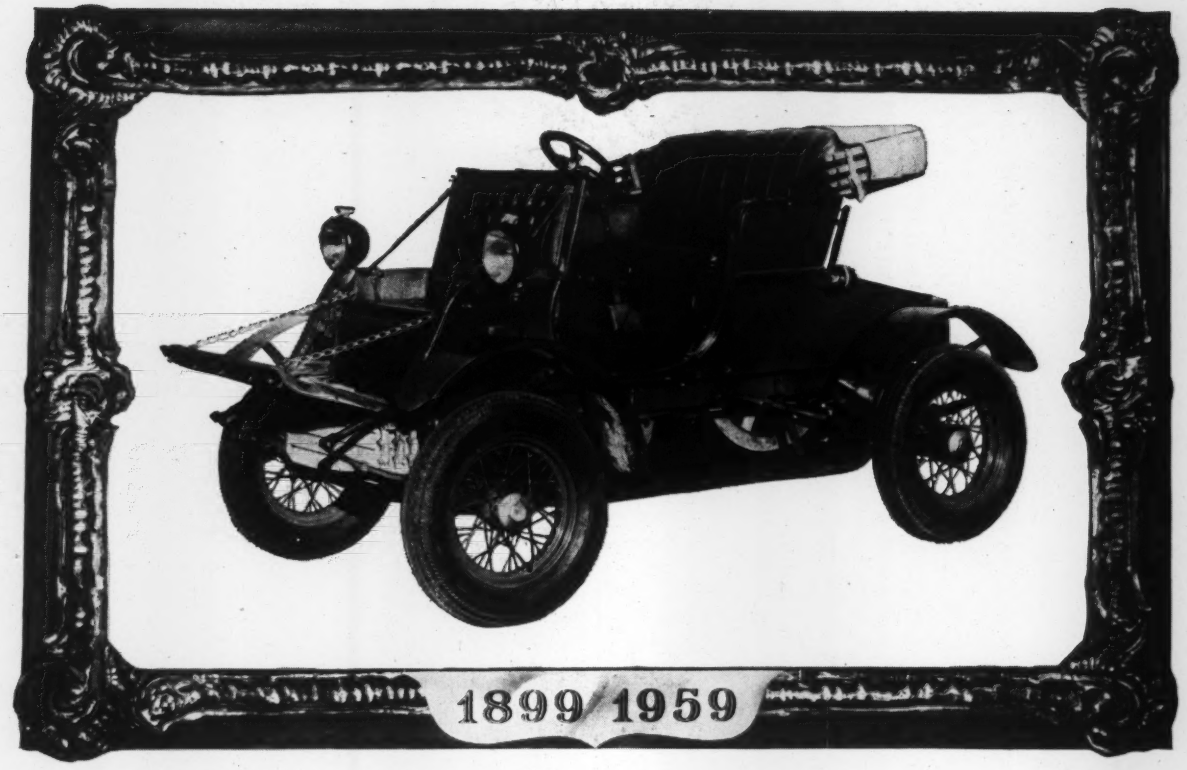

Everything's changed but the trademark on the bearings

BUILT by the St. Louis Motor Car Co. in 1899, this car was the first equipped with Timken® tapered roller bearings. It's still running. And today every make of American car but one uses Timken bearings. The things that the trademark "Timken" stands for haven't changed. It still means the highest quality, the best-known name in bearings, and the kind of service you can't get anywhere else. It means better performance with longer life and less maintenance in machine tools, steel mills, heavy construction machinery, farm implements and tractors —wherever wheels and shafts turn.

"Timken" is a registered trademark that identifies all products of The Timken Roller Bearing Company—tapered roller bearings, fine alloy steel bars, seamless steel tubing and removable rock bits.

It's to your advantage to remember that "Timken" is not a type of product. It's your assurance of the best in tapered roller bearings, fine alloy steels and removable rock bits. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

TAPERED ROLLER BEARINGS • REMOVABLE ROCK BITS • FINE ALLOY STEEL

TIMKEN®

first in quality for 60 years